AFIT/GLM/LA/93S-36

A STUDY OF THEORETICAL MODELS FOR MANAGING TECHNOLOGY CHANGE AND A COMPARISON TO A RADIO FREQUENCY IDENTIFICATION IMPLEMENTATION

THESIS

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THESIS

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Preface

The purpose of this study was to develop a model and guidelines that could be used by managers for implementing technologies in their organizations and compare an actual advanced technology implementation to that model.

Individuals involved in the technology implementation were interviewed and their responses compared to the aggregate theoretical model. However, the sample sizes of the interview groups were too small to perform t-tests to see if there were significant differences between the actual implementation and the aggregate model. This research provided promising support for the aggregate model. Future research should continue to develop and refine a reliable technology implementation model.

We had a great deal of help writing this thesis and obtaining interviews for our study. We are especially thankful to our thesis advisors, Lieutenant Colonel Miller and Major Pappas, for their patience, guidance, and constant encouragement. We would also like to thank the MITLA, Kelly AFB jet engine overhaul facility, ASI, and SAVI Technologies personnel for their honesty, support, and interest in our research. Most of all, we owe a debt of gratitude to our loving wives, Carrie and Denise, for their understanding, support, and tolerance when they had to handle more than their share of the family responsibilities.

Mark S. Reboulet　　　　Phillip L. Robinson

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Abstract

This research developed an aggregate model for technological implementation in organizations. The aggregate model drew information from various theoretical models and aggregated those elements that were common to several of the models. Those elements included: information availability, anticipated profitability, probability of success, user attitudes, political attitudes, external pressure, teamwork, strategic planning, resource availability, and training. A sample of individuals who were involved at various organizational levels of a Radio Frequency Identification (RFID) implementation were interviewed to see if the aggregate model could be useful to managers. The researchers found evidence that each of the elements of the aggregate model could be beneficial to managers considering implementing new technologies in their organizations. Also, the researchers found that individuals at different organizational levels tended to view these elements differently. Additionally, the researchers recommended several elements that could be added to the model. Future research should be conducted to determine if these additional elements should be added to the aggregate model and to determine if the model is useful for various types of technologies.

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I. Introduction

General Issue

The United States Air Force, as well as the other Department of Defense (DOD) Services/Agencies, has been managing technological change for many years. Numerous sources of information outlining the effects of technological change on organizations exist, yet organizational attempts to implement new systems routinely flounder and occasionally fail. With this information available, the questions become, "how useful is the information and do applicable guidelines exist for effectively implementing advanced technologies?"

In particular, Automatic Identification Technologies (AIT) developed in the early 1970s sought to improve the data collection methods and to increase the accuracy of data entered into Management Information Systems (MISs). The DOD initiated the initial DOD AIT program, Logistics Applications of Automated Reading Symbols (LOGMARS), in 1983. The LOGMARS initially focused on the standardization and implementation of barcode technology in several logistics areas within DOD. Barcodes were successfully implemented throughout the AF and DOD, in such areas as

depot receiving and shipping, Precision Measurement Equipment Laboratory (PMEL), medical records tracking, and depot maintenance tracking (LOGMARS, 1993).

In 1984 the Office of the Assistant Secretary of Defense (OASD) for Manpower, Installation, and Logistics initiated a new, innovative DOD information technology program (Calhoun, 1984). Later, the department enacted the Microcircuit Technology in Logistics Applications (MITLA) program to oversee the introduction of advanced, state-of-the-art microcircuit based AIT systems through the logistics functions of DOD. One of the advanced technologies managed by the MITLA Program Management Office was Radio Frequency Identification (RFID). RFID has capabilities and strengths far beyond the traditional serial keyboard data entry method. "Traditional collection methods produce error rates ranging from one in 30 for handwritten documents to one in 300 for keyboard input. Automatic Identification systems operate in the accuracy range of one error in three million entries, and most offer audible entry feedback for immediate error correction" (Soltis, 1985:55). RFID with its keyless data entry has tremendous potential throughout the AF and other DOD Services/Agencies to help resolve logistical tracking and identification applications and source data collection issues and increase the data accuracy of source data. A 1986 Deputy Assistant Secretary of Defense Memorandum launched the Microcircuit Technology in Logistics Applications (MITLA) program, which, among other things,

oversees the implementation of RFID throughout the DOD and establishes DOD policy and procedures for the implementation of this technology throughout the DOD. A Senior Advisory Group (SAG) comprised of Assistant Secretaries of the Air Force, Army, Navy, Marine Corps, Defense Logistics Agency, and General Services Agency was established to provide leadership and direction. This SAG is chaired by the Office of Assistant Secretary of Defense (OASD) Production and Logistics. Over the past six years, several prototypes have been initiated throughout the various services. Many of these prototypes strive to resolve the complex data collection issues associated with the tracking and identification of military material throughout the logistics pipeline. The DOD employed RFID to track army tanks and major end items through an overhaul facility, track pre-positioned trucks and supplies through scheduled maintenance, track and manifest ammunition returning from Desert Storm, and track and identify jet engine parts and subassemblies through an AF jet engine repair facility (DOD: 11-33). These applications represent cases for management of technological change within the structure of the AF.

Separate from the technology, are several models which address the proper implementation of technology. Examples are the Organic Model and the Ambidextrous Model for managing technological change. These models were developed outside the DOD to provide guidelines for influencing the

amount of change in an organization's production technology (Daft, 1983:269).

The purpose of this thesis research is to determine how well an implementation of RFID correlates with the theoretical models for technological change. By comparing the theoretical model with an actual implementation, insights and recommendations for technology implementation guidelines may become apparent. Inferences to other technology implementations also may be appropriate.

Specific Problem

The researchers initiated this study to: (1) Review existing theoretical models for managing technological change, (2) establish an aggregate theoretical model consisting of common implementation elements for implementing RFID within the AF, (3) and compare the aggregate theoretical model to an existing RFID implementation.

Research Question

This thesis provides a comparison between existing theoretical models for managing technological change and a limited implementation of RFID at Kelly AFB, F-100 jet engine repair center.

Investigative Questions

The research involved in this thesis consists of: an extensive review of the literature concerning technological

change models; interviews with military and civilian personnel working with RFID technology, to include Kelly AFB jet engine repair facility personnel and contractor personnel involved in providing RFID to the AF and other DOD Service/Agencies. The specific investigative questions are:

1. What technology implementation models exist throughout industry?

2. What are the key variables/characteristics of each model and what are the common implementation elements?

3. To what degree did the RFID implementation at Kelly AFB, F-100 Jet Engine Repair Center represent the aggregate technology implementation model? Were the recommendations of the models followed by Kelly AFB? What were the consequences/results?

4. What elements if any were incorporated in the case study RFID implementation, but were not included in the aggregate of the theoretical models?

Limitations of the Study

1. Due to the time constraints placed on the development of this thesis, the models for managing technological change will be compared to only one limited implementation. This may be insufficient to draw far-reaching inferences to other technologies or technology implementations.

2. RFID is in the beginning stages of product development. Much of the literature may be biased in favor of the technology.

3. Since the RFID project at Kelly AFB jet engine repair center has not been fully implemented, some aspects of the theoretical models may not yet be evident in this limited implementation.

4. The sample of potential case study candidates is limited to one jet engine repair facility. Unique circumstances reflected in the implementation may not be transferable to other technologies or implementations.

5. Since this research, as discussed in Chapter III, is more qualitative than quantitative, limited statistical analysis is applicable.

Chapter Summary

This Chapter presented the basic management problem of this thesis - the comparison of the theoretical technology change models with an actual RFID implementation. The systematic implementation of technologies such as RFID could save valuable DOD resources. The researchers briefly introduced the LOGMARS and MITLA programs and some of the models for managing technological change. The LOGMARS and MITLA programs, as well as other technology based programs, may benefit from the findings of this research. Finally, the researchers identified investigative questions and pertinent limitations of this thesis.

Overview of The Remaining Chapters

Chapter II contains an overview of the literature concerning technology change models. Specific implementation guidelines for RFID applications are also outlined in the chapter. The methodology used in the collection and analysis of the data required to answer the investigative questions is presented in Chapter III. An analysis of the research data collected from the RFID case study at Kelly AFB Jet Engine Overhaul Facility is found in Chapter IV. Conclusions and recommendations from the research presented in the first four chapters is provided in Chapter V.

II. Literature Review

Introduction

When new technologies become available, the AF may benefit from the use of the technology, and faces a challenge. The implementation of the technology must be accepted by the users and result in a smooth transition from current accepted practices. An example of one new and innovative technology is Radio Frequency Identification (RFID). RFID is a fast growing, state-of-the-art technology that is used to identify, track, and define objects within a specified area. Concurrent with this technology is the development of a number of models to help managers successfully implement technology in their organizations. This review will explore literature related to implementation models for advanced technologies and ascertain common elements. The next objective is to develop an aggregate technology implementation model and compare an actual implementation of RFID at Kelly Air Force Base to that model. This review begins with the introduction of RFID operation and characteristics. Next, various technology implementation models will be discussed and the significant elements identified.

Automatic Identification

Before considering the various technology implementation models and a simplified explanation of RFID

operational characteristics, an overview of Automatic Identification (AUTO ID) technologies will provide a perspective as to where RFID resides.

AUTO ID, when properly implemented, can have a direct impact on labor productivity, space utilization, inventory control, customer service, and operation cost (Soltis, 1985:55). The most common AUTO ID technologies are barcode, OCR Radio Frequency Identification (RFID), voice data entry, and machine vision.

A one-dimensional barcode is a series of white and black bars and spaces that correspond to a combination of digits, letters, or other punctuation symbols (Noaker, 1989:44). A laser scanner or light pen reads the unique barcode pattern, and a computer interprets the code. In the late 1980s, several manufacturers introduced two-dimensional barcode symbologies. These new codes, which can store thousands of characters, were developed to overcome the character limitation of earlier one dimensional barcodes.

OCR features human-readable numbers or letters rather than the bars and spaces of a barcode. A light source scans the character's height and width. "When the character pattern is recognized by the scanner, the data is converted to electronic impulses for transmission to the computer" (Beckert, 1990:74).

Voice data entry uses pattern recognition of words in a pre-programmed vocabulary. The operator speaks the words

into a microphone connected to the voice system hardware. The spoken words are converted to electronic impulses and recognized by the computer (Beckert, 1990:74; Noaker, 1989:44). Voice data entry frees the operators hands to perform other operations.

Machine vision (MV) employs the same principles as barcode and OCR, but the MV's imaging system is more complex. MV involves scanning and identifying labels, objects, or documents and interpreting what it sees (Beckert, 1990:74).

RFID is one member of the above-described family of Automatic Identification technologies aimed at reducing the problems associated with information gathering and input (Kojm, 1991:9). RFID has many advantages over its other optically based AUTO ID technologies. RFID does not require line-of-sight between the tag (label) and the interrogator (reader); provides a more forgiving target orientation; allows data stored on the tag to be reprogrammed without physical contact from the interrogator; can store large amounts of data (32,000 characters in the tag memory); and protects the data stored on the tag from environmental extremes by virtue of the tag casing materials (Kojm, 1991:6). Table 2.1 summarizes the optimum application of each AUTO ID technology.

RFID data collection systems consist of three basic components: Radio Frequency (RF) tag, RF interrogator with antenna system, and a host computer. An RF tag is a

miniature radio transmitter/receiver that is attached to an object requiring tracking or identification. Interrogators are slightly larger radio transmitters/receivers that collect data from the RF tags through the use of radio frequency communications with the RF tag. Once collected the interrogator passes the data to a host computer (Bertschmann, 1992:16). There are many different implementation schemes of RFID systems. Each scheme has advantages and disadvantages. A description of each scheme is beyond the scope of this research.

TABLE 2.1. OPTIMUM APPLICATION OF AUTO ID
(Allen, 1991:32; Beckert, 1990:74)

Type	Best Use in Automated Data Capture
Barcode	Scan distance 2-12", 1-32 characters
OCR	Scan distance 2-12", page(s) of text
RFID	Scan distance > 12", > 100 characters
Voice	Hands-busy and eye-busy processes
MV	High speed inspection

Common Elements of an RFID System. The next section is intended to be a simplistic overview of an RFID system implemented in commercial industry.

RFID Tag. The RFID system uses an integrated circuit, usually contained in the RF tag, to record, store, and transmit data to the interrogator. "The tag includes a coil (antenna), transceiver electronics, control logic, and some form of nonvolatile storage or memory" (Kojm, 1991:9). Some RFID systems, taking advantage of the on-board memory, provide a write capability that allows the system to add

information to the transponder through communication with the interrogator (Beckert, 1990:74).

Interrogator. The interrogator is the device, usually separate from the host computer, containing the digital electronics for managing the communications to and from the tags within its communications range. Through various RF communications protocols and an appropriate antenna system, the interrogator receives and transmits data to and from RF tags within its communications range. During these communications sessions, data elements stored on the tag such as date received, new routing instructions, or other identification or control data can be updated (Kojm, 1991:12). An interrogator containing a microprocessor can function as a limited local system controller. This allows the interrogator to process data received from the RF tag and make decisions based on information contained in the interrogator's memory module. The interrogator can process fast simple decisions locally without burdening the controlling host system (Draxler, 1988:7).

Host System. The host computer in an RFID system could be any type of computer platform with a communications protocol that is compatible with the interrogator. The main function of the host computer is to translate the data into its required format for use in the particular user application (Kojm, 1991:12).

RFID System Characteristics. There are several types of RFID systems that may be classified by power source,

method of programming, capacity, and intelligence (Ames, 1988:15-16).

Power Source. An RFID system may be categorized by the tag's source of power. Some RF tags contain batteries to power all elements of the tag. These systems are categorized as active. Other tags categorized as passive use the battery to power certain elements of the tag. Power contained in the RF signal is converted to meet the power requirements for the other elements of the tag (Ames, 1988:16).

Method of Programming. RFID systems are categorized by their method of programming. If a tag can be programmed only by factory personnel, it is a read-only tag. If a tag can be programmed in its operating environment, it is a read/write tag (Ames, 1988:15).

Capacity. Capacity is a third characteristic used to categorize tags. "Level I" tags can store one bit of information. "Level II, III, and IV" tags can store 8 to 128 bits, 48 to 512 bits, and 256 bits to 256,000 bytes of information, respectively (Ames, 1988:15).

Intelligence. The final method of classification is intelligence. An intelligent tag is one that has information processing or decision making capability. A dumb tag is one that does not have these capabilities (Ames, 1988:16).

Theoretical Models

With an understanding of the operation and characteristics of RFID, various technology implementation models will be discussed. The first part of this discussion centers around theoretical models that are used in the implementation of new technologies. The next part of the discussion will draw out some guidelines provided by the authors for successful technology implementation.

McCardle and Oliva Models. Prior to implementing a new technology, a firm undergoes a decision process in which it must decide whether or not to adopt the technology for itself. Kevin McCardle has developed a model describing the firm's decision process in adopting a new technology (McCardle, 1985). His model revolves around the amount of information a firm has regarding the innovation and the corresponding estimate of the profitability of the innovation (Oliva, 1991:607). A firm considering adoption of a new technology begins with a certain amount of information that includes an estimate of the profitability of the technology. If the profitability of the technology is very high, the firm will make the decision to adopt the technology (region I in Figure 2.1). If the profitability is low, the firm will, wisely, decide not to implement the technology (region III in Figure 2.1). If the profitability, however, is neither high nor low (region II in Figure 2.1), the firm will continue to gather information

until it feels it has enough to make an "accept or reject" decision.

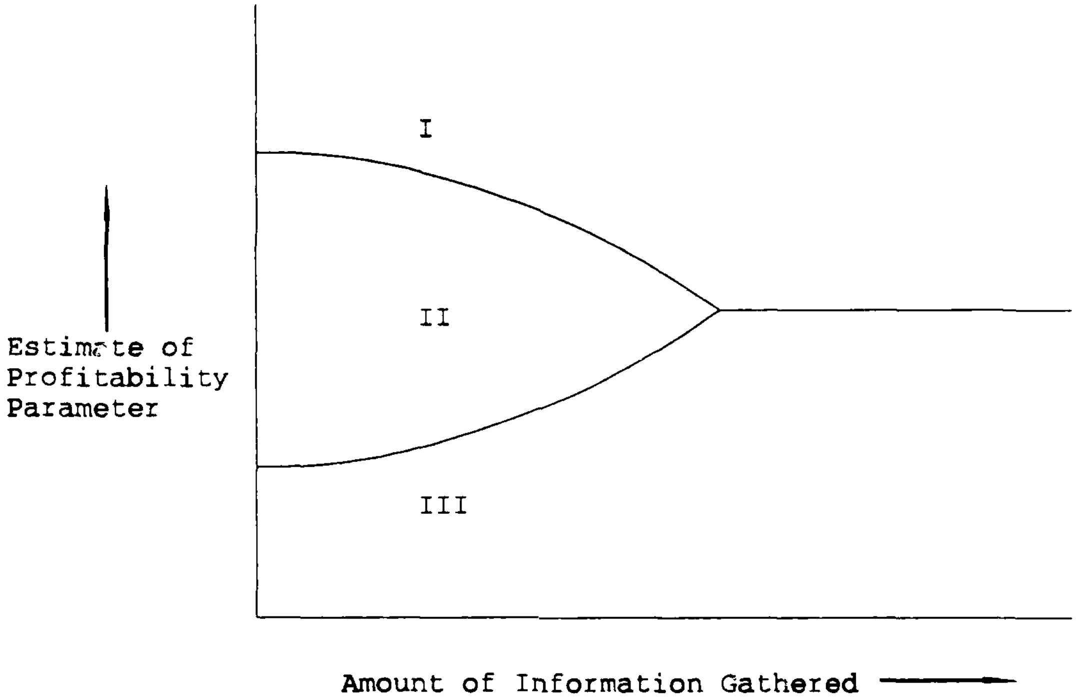

Figure 2.1. McCardle's Model (Oliva, 1991:608).

Oliva takes McCardle's model and adds the cusp model of the catastrophe theory to develop another model of a firm's decision to adopt a new technology. The cusp model generates a response curve that is defined as $Z^3-X-Y \cdot Z=0$ (Oliva, 1991:608). Z is the dependent variable (the probability of adopting the technology) and X and Y are the independent variables, X represents the amount of information available and Y represents the profitability estimate. Oliva's extended version of McCardle's model is

shown in Figure 2.2. The similarity to McCardle's model can be seen in the floor of the cube.

Oliva has added the upward dimension or the probability of adopting the technology. The fold in the response surface "provides for qualitative aspects of adoption behavior not directly intuited from using McCardle's approach. Specifically, a portion of the surface is bimodal, reflecting the uncertainty associated with the decision, when little information exists" (Oliva, 1991:611). The McCardle model results when the area created by the fold is projected downward onto the floor of the cube.

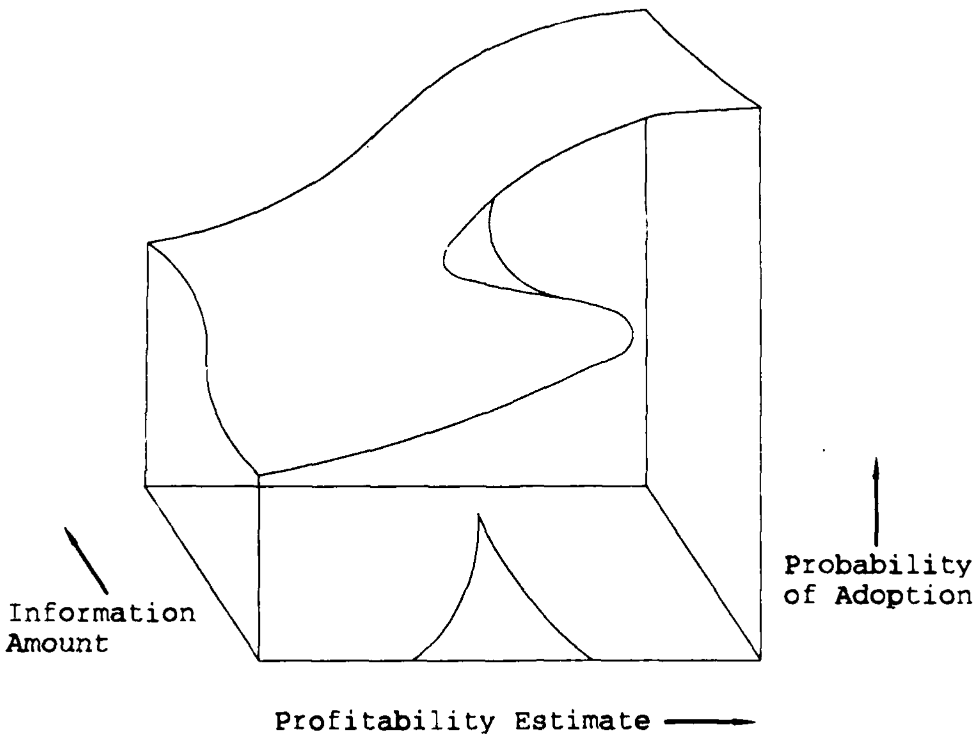

Figure 2.2. Oliva's Extension of McCardle's Model (Oliva, 1991:610).

Oliva's model can provide a useful estimate of a firm's decision process and help the firm match its decision rules to the theoretically best rules. Also, adoption decisions of different industries could be compared to each other (Oliva, 1991:621).

Equity-Implementation Model. This model explores the manager's challenges in overcoming resistance to change when a new technology is implemented. The model is based on the equity theory which states that "in every exchange relationship, individuals are constantly concerned about their inputs, outcomes, and the fairness of the exchange" (Joshi, 1991:231). It is also based on the premise that "there is no fundamental resistance to every change" (Joshi, 1991:230). The equity-implementation model identifies three levels of analysis that an individual may use in deciding whether or not a situation is equitable (Joshi, 1991:231).

At the first level of analysis, the individual compares what he/she will have to give and what he/she will gain after the change to his/her levels of giving and receiving before the change. At the second level of analysis, the individual compares what he/she is likely to get from the change to what the employer is likely to get from the change. If the user feels that the employer is gaining more than he/she is, then he/she will view the change as unfavorable. The user also may get the same feeling if he/she is not involved in the decision to adopt the innovation (Joshi, 1991:232). Finally, at the third level

of analysis, the individual may compare what benefits he/she will get from the change to the benefits to be gained by other users in the affected group. Again, if the user perceives that he/she has not benefited equitably with others in the affected group or that the group has not benefited equitably with other groups, he/she will not view the change favorably (Joshi, 1991:233). Kailash Joshi offers some guidelines for managing the change that is often times distressful to the users (Joshi, 1991:236).

Joshi says that there are two dimensions along which an employer can attempt to improve equity perceptions. First, the employer can try to alter the actual outcomes and inputs of the user. There are several actions that can be taken to increase the outcomes for the users: wage or job status increases, changes in working conditions, negative outcomes minimized, among other actions. The second dimension is to alter the user's perception of the inputs and outcomes. One example of altering user's perceptions is to convince the users to "view the company's survival and financial viability against the competition as a desirable outcome that would bring stability and security to their jobs" (Joshi, 1991:238). Another way for employers to alter the perceptions of inputs and outcomes is to provide training and communications programs to explain why some individuals or groups deserve better treatment.

While this model details a three-level process used by individuals to evaluate the effects of change, there are some limitations expressed by Joshi (Joshi, 1991:240).

1) Possible fear and uncertainty about the nature of changes may make it difficult for users to make an objective assessment.

2) Users may lack awareness of some outcomes and inputs.

3) Users may have mixed feelings about a given change.

TEP Model. Unlike the McCardle and Oliva models, and similar to the Equity-Implementation model, the Technical, Economic, and Political (TEP) model deals with successful implementation of a new technology after the decision to adopt. Although the model specifically addresses advanced manufacturing technology (AMT), the propositions of the authors apply to any technology in that RFID and AMT are both advanced technologies. The authors focus on "the set of decisions involved in implementation" (Dean and others, 1990:130). The TEP model is rooted in the idea that the difficulties in implementing a new technology are a result of ineffectiveness in meeting a combination of technical, economic, and political objectives (Dean and others, 1990:130).

The technical objective is met when the technical requirements associated with the process in which the new technology is used are met (Dean and others, 1990:131). Examples of this technical performance may include shop flow

rate, data accuracy, and data entry speed. The economic objective simply requires that the firm be stronger financially after the technology is implemented than it was prior to the implementation (Dean and others, 1990:131). One possible measure of this objective can be obtained by comparing the unit cost of production before and after implementation of the technology. The political objective is to satisfy users that the new technology will improve their efficiency or meet other relevant goals. It also seeks to persuade users that their organizational status, if altered at all, will be enhanced (Dean and others, 1990:132).

The authors suggest four factors that influence implementation success: tolerance, resources available to the project, the direction of the relationships among the three objectives, and the degree to which the three objectives are balanced (Dean and others, 1990:132).

Users will be more tolerant and receptive to a new system the closer the implementation comes to meeting their expectations. The authors suggest an inverse relationship between expectations and tolerance and follow with the proposition that the higher the level of tolerance the greater chance of successful implementation (Dean and others, 1990:133).

They also make the point that as higher levels of technical, economic, and political resources become

available, the chances of the technology being successfully implemented increase (Dean and others, 1990:133).

Dean and others (1990) also draw a relationship between the three objectives and define these relationships as positive or negative. If achieving an acceptable level for one objective results in achievement of an acceptable level in another of the three objectives, then there is a positive relationship between the two objectives. Conversely, if achievement of an acceptable level for an objective comes at the expense of another objective, there is a negative relationship between the two objectives (Dean and others, 1990:133). As in most decisions, tradeoffs are often made to achieve acceptable, but not optimal, levels of satisfaction. Based on this theory, the authors propose that "the more positive the relationships (or the fewer the tradeoffs) among technical, economic, and political objectives, the greater the likelihood of successful AMT implementation" (Dean and others, 1990:135).

The final factor that may influence implementation success is balance, or the degree to which all objectives are given equal consideration. The authors propose that greater chances of implementation success result from more balance during the implementation process (Dean and others, 1990:136). A pictorial representation of the model is shown in Figure 2.3.

At the corners of the triangles, we see the three objectives previously discussed: technical, economic, and

political. The positive or negative relationships are also shown along the borders of the large triangle. The smaller, internal triangle represents the area of acceptable levels of satisfaction; whereby, implementation is considered successful by those involved. A perfectly balanced decision, for example would be located in the center of the triangle. The size of the inner triangle is representative of the tolerance and resources for any of the objectives. If either tolerance or resources increase, the inner triangle will get bigger (Dean and others, 1990:137). The authors propose that an "unbalanced decision may lead to decreases in tolerance and resources, thus reducing the likelihood of success for subsequent decisions" and ultimately success of the implementation (Dean and others, 1990:140).

The TEP model can help managers more effectively keep their fingers on the pulse of the implementation process. If the implementation begins to weaken or slow down, the model could also assist the manager in locating the cause and taking action to put the process back on track by keeping subsequent decisions balanced.

Lewin's Change Model. While not specifically directed toward the organizational effects generated by technological change, Lewin's model provides some useful information about change in general. Lewin's model is based on the theory that organizations continuously strive to maintain a steady state and require external pressures to initiate internal

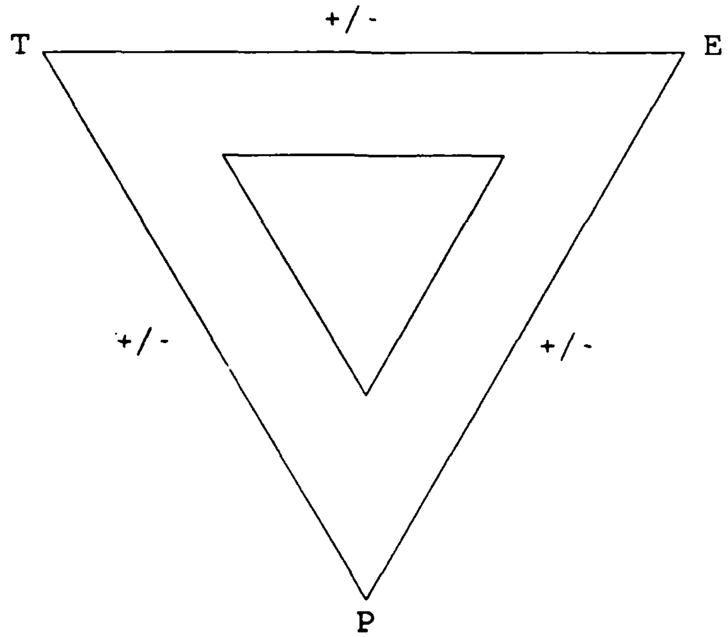

Figure 2.3. TEP Model (Dean and others, 1990:136).

change. These external pressures could range anywhere from regulatory changes to business competition. Organizational change initiated by these pressures occurs at three levels: individual, structural and system, and climate/interpersonal style. Each level requires different change strategies and techniques (Goodstein and Burke, 1991:10). At the individual level, skills, values, and attitudes must be changed. These changes will eventually lead to positive changes in individual behavior. At the structures and systems level, reward systems, work design, reporting relationships, and other similar characteristics are changed. At the climate/interpersonal style level,

conflict, personal openness, decision-making methods, and other activities are managed (Goodstein and Burke, 1991:10).

Lewin's model consists of three steps for managing change in an organization: unfreezing, movement, and refreezing. These three steps must occur at each of the levels discussed in the preceding paragraph. The unfreezing step is where the current practices are viewed as improvable and individuals are convinced that "the way we have always done it" may not be the best way to do it. According to Goodstein and Burke, the unfreezing step may involve

> on the individual level, selectively promoting or terminating employees; on the structural level, developing highly experiential training programs in such new organization designs as matrix management; or, on the climate level, providing data-based feedback on how employees feel about certain management practices. (Goodstein and Burke, 1991:10)

The movement step is when the actual changes are made, and the organization moves into a new way of performing the process. During this step, individuals would be exhibiting changes such as development of new skills or supervisory practices. At the structural level, evidence such as changes in organizational structure and reporting relationships would appear (Goodstein and Burke, 1991:10).

The final step, refreezing, is where these changes are fully incorporated into the organization, and systems are established that make the new behavior secure against change. Evidence of the refreezing step would be actions such as redesigning recruiting practices so that individuals who exhibit the new management style and values are hired,

and reward systems that focus on the new norms are instituted (Goodstein and Burke, 1991:11).

Non-Model Guidelines

Much of the literature written about implementing new technologies, while not defining theoretical models, produces many useful guidelines for installing new technologies in organizations. One such piece of literature is presented by Corbitt and Norman (Corbitt and Norman, 1991). The authors cite three strategies for dealing with technology implementation: power-coercive, rational-empirical, and normative-re-educative (Corbitt and Norman, 1991:639).

The power-coercive strategy involves the use of authority and power to force people into using the new technology. Normally associated with this strategy is a negative effect. For instance, any user who does not effectively use the new technology after a certain time may be fired. This strategy will, undoubtedly, "increase worker productivity within a very short time, but at the same time may create the most internal conflict for the individual" (Corbitt and Norman, 1991:639).

The rational-empirical strategy involves keeping workers informed about all aspects of the implementation, and they will rationally see that the results of the implementation will be to their benefit. Unfortunately,

this strategy has approximately an eighty percent failure rate (Corbitt and Norman, 1991:639).

The normative-re-educative strategy involves working with people as groups and getting the group to put peer pressure on those who do not agree with the group. This strategy takes longer than the other two strategies, but this disadvantage is overshadowed by the advantages: worker development, worker satisfaction, worker productivity, and less internal conflict (Corbitt and Norman, 1991:639).

Additionally, the authors have compiled lists of common threads and critical success factors for successful implementation. These lists are presented in Tables 2.2 and 2.3.

Another source of guidelines comes from a game called "ADVANTIG" for Advanced Technology Implementation Game. The game was developed by Industrial Technology Institute of Ann Arbor, Michigan to emphasize their belief that cooperation and coordination are vital to successful implementation of new technology (Wenzel and others, 1990:50). The game compresses a five-year period in the life of a hypothetical company that has implemented a new technology into five hours. Participants play real-life roles and bring their own objectives and decisions to the game, the goal of which is to implement advanced manufacturing technology in a company while successfully filling the company's orders (Wenzel and others, 1990:50). Through many observations,

TABLE 2.2. IMPLEMENTATION COMMON THREADS (Corbitt and Norman, 1991:640).

1. Manager and worker negative perceptions of change must be openly addressed.
2. Positive factors for change should be reinforced often.
3. Deal with highest stress first.
4. Change must start at top of organization.
5. Informal as well as formal lines of communication must be used.
6. All (or almost all) managers and workers should participate (or be represented) in process and design of organizational change, and not just be affected by it.

TABLE 2.3. CRITICAL SUCCESS FACTORS FOR SUCCESSFUL IMPLEMENTATION (Corbitt and Norman, 1991:640).

1. Client commitment to change (e.g., product champion).
2. Trust on part of management and workers.
3. Open communications.
4. Management commitment (e.g., financial champion).
5. Common view among managers and workers of implementation strategy.

administrators of the game noted five important factors that led to success:

1. Shared decision making.
2. Establishment of a team atmosphere, including good labor-management relations.
3. Sufficient attention devoted to training.
4. The critical importance of strategic planning.
5. A positive vendor/user relationship.

A third source of guidelines comes from Levi Strauss & Co. Inc. In their search for a formal methodology for implementing new technologies, Levi management decided that system selection "should be based on how well the technology furthers the corporate direction as determined by senior

management" (Stevens, 1992:22). Levi determined that, to meet this goal, senior management had to be involved in every step of the technology adoption/implementation process and, consequently, created the Marketing Management Committee (MMC) (Stevens, 1992:22). The committee, comprised of the chief information officer, division presidents, and senior operational managers, is concerned with three issues: "whether a project's objectives fit in with the corporate direction; whether, given the overall corporate strategic and tactical business plans, the cost is reasonable; and given the overall corporate schedule, the timetable is reasonable" (Stevens, 1992:22). Once the MMC selects a project, it appoints a member to sponsor the project and gives him/her overall responsibility for the project. The sponsor then selects a core team to design the system and develop the implementation plan. The next phase is the sign off phase. The design and implementation plan must first be signed off by the information resources person who ensures the technical requirements of the system are met. The plan is then signed off by the core team signifying that the system is satisfactory. The final sign off comes from the senior management sponsor signifying that the requirements of the MMC have been completed and the system meets the strategic goals of the company (Stevens, 1992:24). From this setup, the importance Levi places on strategic consideration when making decisions on new technologies is apparent.

Aggregate Model

With a review of current literature relating to technological implementation complete, an aggregate model that includes the fundamental ideas presented in the literature can be developed. The literature lent itself to division into eight categories: information availability, anticipated profitability, probability of success, users attitudes/expectations, political attitudes, external pressure, teamwork, and strategic planning. These categories were extracted from the models previously discussed and represent the main ideas of each model. The categories and their sources are tabulated in Table 2.4. The relevance of each category is discussed.

Information Availability. Information includes written or oral communications regarding the technology implementation. The McCardle and Oliva models suggested that a firm begins to consider the adoption of new technology with a certain level of information concerning the technology. Depending on the firms estimate of the profitability of the technology, the firm may need to gather additional information before a decision is reached (Oliva, 1991:607). Therefore, the amount of information is linked to the pre-implementation technology adoption decision.

In Lewin's Change Model's unfreezing step, data-based feedback informs management as to the employee's feelings

TABLE 2.4. AGGREGATE MODEL MATRIX.

Common Elements	McCardle & Oliva Model	Equity Implementation Model	TEP Model	Lewin's Change Model	Corbitt and Norman	ADVANTIG	Levi Strauss
Information	X			X	X	X	X
Profit	X		X				X
Probability of Success	X		X				
User Attitudes		X			X		
Political Attitudes			X		X		
External Pressure				X		X	
Teamwork						X	X
Strategic Planning						X	X
Resource Availability			X				
Training				X	X	X	X

practices are viewed as improvable (Goodstein and Burke, 1991:10).

One of the three strategies for dealing with technology implementation presented by Corbitt and Norman, is the rational-empirical strategy. This strategy involves keeping workers informed about all aspects of the implementation. As a result the workers will rationally see the benefits of the technology implementation (Corbitt and Norman, 1991:639). They also imply that a common implementation thread is the notion that informal as well as formal lines of communication must be used during the implementation. Open communication is a critical success factor for successful implementation (Corbitt and Norman, 1991:640).

The ADVANTIG game provides for more user involvement than Corbitt and Normans' open communications. Through many observations, administrators of the ADVANTIG game noted that shared decision making was an important factor for success (Wenzel and others, 1990:50).

Levi Strauss and Co. determined that senior management involvement was required in the entire technology adoption/ implementation process; consequently, they created a Marketing Management Committee (MMC). Since information resources are critical to the decision process, Levi Strauss appointed the chief information officer as a member of the MMC (Stevens, 1992:22).

The amount and flow of information from the technology adoption decision through the implementation process was

seen as a key variable by five of the technology implementation models.

Anticipated Profitability. Profitability is considered the return or benefit received from technology implementation once all operating expenses have been met. Operating expenses include the initial implementation cost as well as any operating cost after implementation. Benefits include increased market share and or lower operating expenses as a result of lower costs for the firm. In a non-profit organization, profit may be equated to cost savings or cost avoidance resulting from the technology implementation.

The McCardle and Oliva models suggested that a key decision in the adoption of a new technology was the profitability of this technology. If the profitability is low, the new technology will not be adopted. If the profitability is high, the firm decides to adopt the new technology. However, if the profitability is neither high nor low, the firm will gather additional information until a profitability decision can be reached (Oliva, 1991:607).

The TEP Model suggested that some of the difficulties in the implementation of a new technology were rooted in ineffective economic objectives. The economic objective is for the firm to be stronger financially after the technology is implemented than prior to the implementation (Dean and others, 1990:131). This implied a requirement for the

implementation of the technology to yield a more profitable organization.

Among other tasks, Levi Strauss's MMC was concerned with whether the cost of new technology implementation was reasonable (Stevens, 1992:22).

Profitability, cost, and benefits are important factors in the pre-implementation decision of new technology. If benefits do not exceed costs, implementation is not feasible.

Probability of Successful Adoption. The term "success" may have multiple meanings depending on the goals of the organization. Success in the context of this paper shall be the measure of how well the technology implementation met or exceeded the goals and objectives for the proposed or implemented technology implementation.

To account for the uncertainty in the technology adoption decision process, Oliva added an upward, third dimension to the McCardle model which relates the probability of adopting the technology to the McCardle model (Oliva, 1991:611).

The TEP model states that difficulties in implementing or unsuccessful implementations of a new technology are a result of ineffectiveness in meeting a combination of technical, economic, and political objectives (Dean and others, 1990:130). In addition, higher levels of technical, economic, and political resources increase the chances of

the technology being successfully implemented (Dean and others, 1990:133).

Although subtle, the probability of successfully implementing technology is a factor in the decision to adopt the technology as well as influencing its success.

Users Attitudes. Users are present at multiple levels in organizations deciding to implement new technology. The senior managers are more concerned with the financial position of the organization. The first level of management is concerned with the impact of the new technology on his or her department. The working level user is concerned with how the technology will effect his or her job. Each of these attitudes toward the technology implementation could be quite diverse.

The Equity Implementation Model addresses the resistance to change, based on the user's attitudes, when a new technology is implemented. These attitudes are based on how the individual views their inputs to the process, outcomes resulting from their inputs, and the fairness of the exchange. The more positive these attitudes, the lesser the resistance to technology change (Joshi, 1991:231).

Even if the user's attitude is positive, Corbitt and Norman advise that a common view among managers and workers of implementation strategy is critical to the success of the implementation (Corbitt and Norman, 1991:640).

A political objective of the TEP model is to satisfy users or change their attitudes so they will believe that

the new technology will improve their efficiency, enhance their organizational status, and meet other relevant goals (Dean and others, 1990:132).

Political Attitudes. Politics encompasses the formal and informal procedures and power structure underlying the operation of an organization.

The TEP model suggested political attitudes, as well as user attitudes, factor into the success of technological implementation. The political objective is to convince users that the new technology will improve their efficiency or meet other relevant goals (Dean and others, 1990:132).

The power-coercive strategy of Norman and Corbitt involved the use of authority and power to force people into using the new technology. Although the strategy normally produces negative effects, it represents a strategy still applied today (Corbitt and Norman, 1991:639).

External Pressure. External pressures are forces outside the organization such as competition and economics that move an organization toward change. Many times organizations are forced to adjust or change due to external factors.

Lewin's model was based on the theory that organizations continuously strive to maintain a steady state and require external pressures to initiate internal change. These external pressures range from regulatory changes to business competition (Goodstein and Burke, 1991:10).

Teamwork. Teamwork suggests effective cooperation and coordination between all parties involved in or affected by the technology implementation.

The establishment of a team atmosphere, including good labor-management relations was one of the five important factors in the ADVANTIG game (Wenzel and others, 1990:50).

Levi Strauss's commitment to teamwork was evident in the creation of the MMC (Stevens, 1992:22). The committee or team, comprised of the chief information officer, division presidents, and senior operational managers is concerned with the implementation feasibility and overall implementation strategy.

Strategic Planning. Strategic Planning implies long term goal setting and planning strategies to meet those goals in an organization. The critical importance of strategic planning was identified in the ADVANTIG game as an important factor that led to the successful implementation of technology (Wenzel and others, 1990:50). Levi Strauss's management based system selection "on how well the technology furthers the corporate direction as determined by senior management" (Stevens, 1992:22).

Resource Availability. Resources include any specialized labor, equipment, or conditions which are required for the successful implementation of a technology. The TEP model suggested that one factor that influenced implementation success was the availability of resources for the project (Dean and others, 1990:132).

Training. Training is an educational process which familiarizes the user with the appropriate aspects of the technology implementation to allow the user to use the new technology properly.

Chapter Summary

This chapter explored the literature related to implementation models for advanced technologies and ascertain common implementation elements. This review began with the introduction of RFID operations and characteristics. Next, various technology implementation models were discussed and the significant elements identified. An aggregate model of these significant implementation elements from each model was developed. A matrix was developed to display each model's support for the aggregate elements. Each of the aggregate elements were operationalized and discussed.

Overview of Chapter III

The next chapter will provide the research design and methodology for determining how well the actual RFID implementation at the jet engine overhaul facility at Kelly AFB supports the elements of the aggregate model. The steps, necessary to answer the investigative questions outlined in Chapter I, are provided in the next chapter.

III. Methodology

Introduction

This chapter describes the procedures used in the collection and analysis of the data required to answer the investigative questions posed in Chapter I. These questions are derived from the research objective of examining an Air Force application of RFID technology to determine to what extent this application parallels theoretical models for technology implementation.

Specific Problem

The Air Force continuously implements advanced technologies with mixed success. Several models discussed in the literature review were developed to assist organizations in implementing new technology. Through careful examination of the relationship between these theoretical models and a specific implementation, correlations which may guide future implementations of advanced technology within the AF and other DOD Services/Agencies became apparent. The purpose of this research was to examine an implementation of advanced technology and determine to what extent this application paralleled theoretical models for technology implementation.

RFID was selected as the advanced technology for comparison with the technology implementation models because it represented a new, innovative technology which had not

gained wide acceptance throughout the DOD. RFID also represented the potential for significant productivity savings for the AF and DOD in times of restrictive funding and uncertain budgets. The AF jet engine depot facility located at Kelly AFB was selected as the comparison application because this application was in the implementation stage. Also, this facility was one of the first large-scale implementations of RFID in the AF. Other smaller proof-of-principle projects would not have provided a valid test of the aggregate technology implementation model. In addition, the tracking and identification techniques employed by this project may be exported to other AF or DOD depot facilities once the concepts and techniques mature.

Investigative Questions Methodology

The core of this formal, descriptive research was the methodology by which the research was conducted. The remainder of this chapter details the steps necessary to answer the research and investigative questions. Each of the following research and investigative questions were addressed separately.

1. What technology implementation models existed? A thorough literature review of applicable technology implementation models was presented in Chapter II. Each model was summarized.

2. What were the key variables/characteristics of each model and what were the common implementation elements? Once the models were analyzed, the key variables and characteristics of each model were identified. Next, the significant implementation elements were extracted and formulated into an aggregate technology implementation model.

3. How did the RFID implementation at Kelly AFB, F-100 jet engine repair center represent the aggregate technology implementation model? Were the recommendations of the models followed by Kelly AFB personnel? What were the consequences/results? The researchers personally administered the questionnaire (see Appendix) at the F-100 jet engine repair center at Kelly AFB.

4. What elements if any were incorporated in the case study RFID implementation, but were not included in the aggregate of the theoretical models? As part of the questionnaire, respondents were asked if there were any additional factors that were considered in their implementation or if they felt the researchers left out any potential considerations. Implementation elements accomplished by the consensus group at Kelly AFB which were not identified as a common element in the aggregate model, but contributed positively or negatively to the success of the implementation, were identified and are discussed in Chapter IV.

Research Design

The first two investigative questions were answered through the literature review, Chapter II. The remaining questions were addressed through the case study research method.

There were several research methods available for this thesis. These methods include experiment, survey, archival analysis, history, and case study. Yin suggests that there are three conditions for determining the proper fit of a research strategy (Yin, 1989). "These three conditions consist of: the type of research question posed; the extent of control an investigator has over actual behavior events; and the degree of focus on contemporary as opposed to historical events" (Yin, 1989:16). These conditions are shown in Table 3.1.

The case study research method was preferred to other research methods such as experiment and survey, because of the nature of the third investigative question. Yin, identified case study as the preferred method when "a 'how or why' question is being asked about a contemporary set of events, over which the investigator has little or no control" (Yin, 1989:20). Since the nature of the third research question involved how the RFID implementation represents the aggregate technology implementation model, a case study was the preferred alternative. In addition, the researchers had no control over the behavior of the events. Instead, the researchers provided an explanatory study of

TABLE 3.1. RELEVANT SITUATIONS FOR DIFFERENT RESEARCH STRATEGIES (Yin, 1989:17).

Strategy	Form of Research Question	Requires Control Over Behavioral Events?	Focus on Contemporary Events?
Experiment	how, why	yes	yes
Survey	who, what,* where, how many, how much	no	yes
Archival Analysis	who, what,* where, how many, how much	no	yes/no
History	how, why	no	no
Case Study	how, why	no	yes

* "What" questions, when asked as part of an exploratory study, pertain to all five strategies?

the models as well as the RFID implementation. A case study as defined by Yin is as follows:

> A case study is an empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when the boundaries between the phenomenon and context are not clearly evident; and in which multiple sources of evidence are used. (Yin, 1989:23)

This research satisfies Yin's definition of a case study. The researchers related theoretical models of technology implementations to an actual RFID implementation. The connection between the aggregate theoretical model required qualitative analysis. Finally, several sources of evidence, such as a literature review, structured on-site and off-site

interviews, and on-site observation of the RFID system implementation were used.

Quality of Research Design. The quality of a research design can be judged according to several logical tests. These tests include construct validity, external validity, and reliability (Yin, 1989:40). Construct validity involves the establishment of correct operational measures for the concepts under study. External validity concerns the domain to which a study's findings can be generalized. Reliability demonstrates that the operations of the study can be repeated with similar results (Yin 1989:40-41).

Survey Instrument. The next step involved the case study analysis of the RFID application at Kelly AFB, F-100 engine repair facility. The nucleus of this analysis was the development of a structured survey (see Appendix) to ascertain how well this RFID application implementation matched the implementation elements of the aggregate technology implementation model. The structured interview conducted by this research team consisted of questions related to the aggregate model implementation elements. An interval sliding scale from 1-7 was used to assess the responses. The completed questionnaire was pre-tested at AFIT with eight AFIT LA graduate students. The student comments resulting from the pre-test were incorporated into the structured interview instrument.

Survey Population. The field questionnaire was administered through telephone and personal interviews at

Kelly AFB, Wright-Patterson AFB, Washington DC, and Palo Alto, California. The target population for the structured interviews included the following groups: Process Engineering Section Chief for the Engine Production Division, Kelly AFB; RFID implementation engineering staff at Kelly AFB; F-100 engine repair line personnel at Kelly AFB; SAVI Technologies and Applied Systems Institute (RFID implementation contractor); and the Microcircuit Technology in Logistics Applications (MITLA) Program Management Office. These groups represented the organizations responsible for the RFID technology, the implementation of the RFID technology, and the users of the RFID technology. A more representative case study was achieved by collecting information from multiple facets of the RFID implementation at Kelly AFB.

Data Collection. Data for this study was collected by means of face-to-face and telephone interviews with people in various levels of responsibility as described in the previous section. A non-probability census of each group, within the population was accomplished. The interviews posed general questions concerning the aggregate elements based on the interviewee's previous experience with other technology implementations. From this information, general attitudes toward each of the common elements was assessed. Each general question was followed by scaled questions designed to assess each groups perspective of the importance of the related element.

Statistical Analysis. Once the interviews were completed, the qualitative information from the interviews was descriptively analyzed to determine if the perceptions of the populations interviewed supported the aggregate implementation model proposed by this thesis. The information was descriptively summarized by interview group and aggregate model element. Descriptive differences between the various groups for each aggregate implementation element were investigated.

The quantitative information from the interviews was statistically analyzed. The contractors were represented by a sample size of four. MITLA, upper management, and middle management were represented by a sample size of one. The sample size of the workers interviewed (eleven) was limited by the time available in the two days the researchers spent at Kelly AFB and by the researcher's efforts to create minimal disruption to the work force at the engine facility. The worker sample size was not large enough to get a random probability sample. T-tests were not performed at an alpha of .05, as planned, to see if there were any significant differences between the responses of each group interviewed.

Chapter Summary

This chapter discussed procedures used in the collection of data required to answer the investigative questions. The potential of RFID was offered as justification for choosing this technology and the F-100

overhaul facility application for this case study analysis. The techniques and methodologies used to research, document, and answer each investigative question were provided. The primary methodology for addressing the theoretical technology implementation models was the literature review. The methodology for addressing the case study of the jet engine repair facility was telephone and personal interviews with the experts, managers, contractors, and workers involved in the RFID implementation.

Overview of Chapter IV

The analysis and answers to the investigative questions are provided in Chapter IV. The identification of common implementation elements among the various technology implementation models, documentation of the aggregate technology implementation model, and a case study of the RFID jet engine application are discussed in Chapter IV.

IV. Comparison of the Aggregate Implementation Model and the RFID Engine Overhaul Application

Introduction

The common elements of the aggregate implementation model have been examined. A comparison between this model and the RFID application at Kelly AFB jet engine overhaul facility can be made. There are many opportunities within the AF and DOD for RFID application. This section is not intended to describe all the systems processes of an engine overhaul facility. Instead, the focus is on the RFID data collection technique employed at the jet engine overhaul facility at Kelly AFB, TX. This chapter will discuss the engine overhaul facility, the Inventory Tracking System (ITS), the manual data collection process, the data collection problem, the RFID solution, and analyze the structured interview results. As of the date of this research, the RFID system had not been implemented; therefore, pre-implementation data was collected and analyzed. The conclusions of this study, therefore, apply only to the pre-implementation phase of technology implementation and do not necessarily apply to installation or post-implementation phases.

RFID Project at Kelly AFB

The Kelly AFB jet engine overhaul facility handles the repair of three types of engines: (1) the F-100 and F-200 engines used for F-15 and F-16 fighters, (2) the T-56 engine

used on C-130 transports, and (3) the TF-39 engine used in the C-5 Galaxy transport. The overhaul function entails four key processes: disassembly of the engine into its components, cleaning and inspection of the components, repair of the components (if necessary), and reassembly of the engine (Bertschmann, 1992:4).

> Since refurbishment can reach a cost of one half million dollars per engine, accurate and timely tracking of the movement of engine components through the overhaul facility is important to ensuring that performance is optimized while costs are minimized. (Bertschmann, 1992:4)

To accomplish this goal, Kelly AFB implemented an ITS, which included an on-line parts location query capability for parts located throughout the facility. The RFID prototype system will track approximately 100 components for Royal Saudi Air Force F-100 engines overhauled by the facility. Four buildings involved in the overhaul process will be outfitted with the RFID system: building 360 (entry-point for engines), building 324 (engine augmenter repair area), building 301 (plating shop), and building 348 (fuel control module repair) (Bertschmann, 1992:5). Figure 4.1 shows how the four buildings are interrelated. The existing ITS system uses a "black box" hub to conduct communications between work stations and the ITS central computer. The RFID project will utilize this existing system as well as the existing network (Bertschmann, 1992:5).

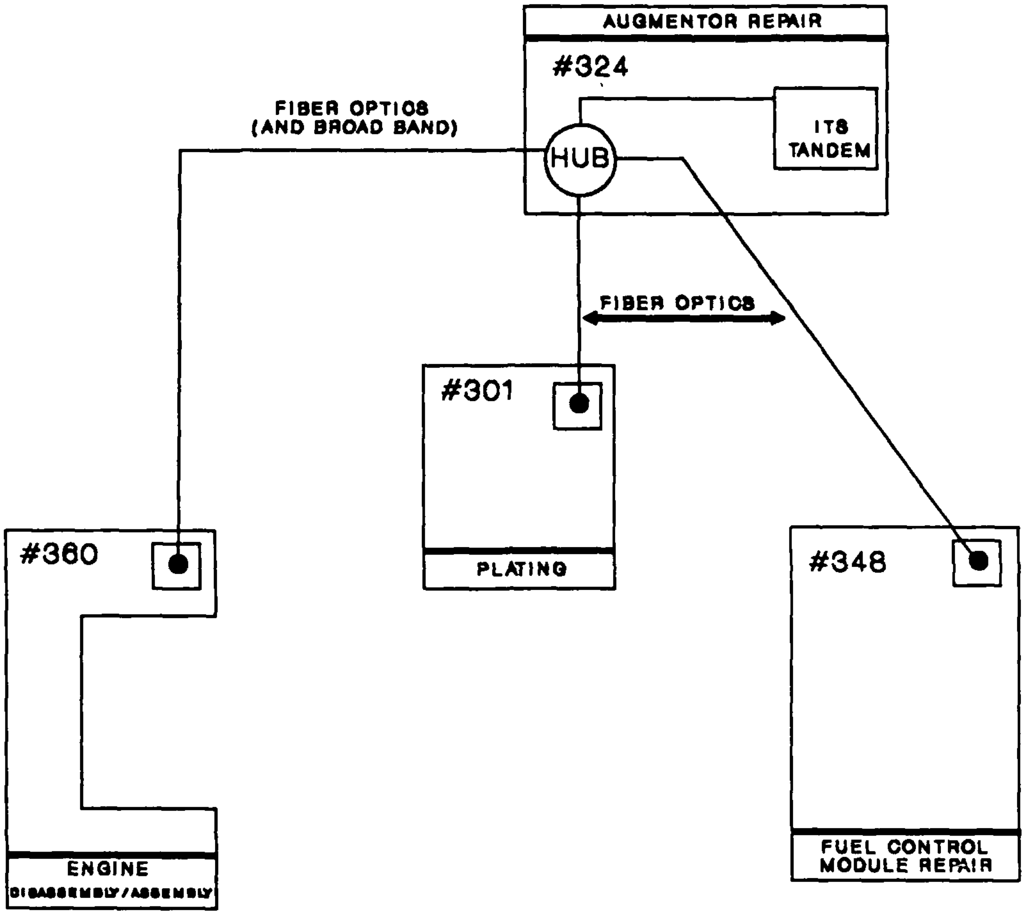

Figure 4.1. Kelly AFB Engine Overhaul Facility Layout (Bertschmann, 1992:6).

<u>The ITS System</u>. The ITS workstations consist of Tandem-based CRTs (50), and some PCs which have the capability to retrieve, display, and, to a limited degree, update the ITS central database. The central database located on the Tandem is developed in COBOL and maintained by software engineers at Tinker AFB, OK. The ITS database holds all applicable data pertaining to the engines overhauled by the facility and associated engine parts. However, keeping the ITS data current with location and status information requires accurate worker input through

the ITS workstations. The RFID system will assist in the updating and tracking function (Bertschmann, 1992:6-7).

The Manual Data Collection Process. As engines arrive, under the current manual data collection process, they are inducted into the ITS system through manual key-entry and automatically assigned an eight-digit Item Tracking Number (ITN) by ITS. ITS also generates a Work Control Document (WCD) and an embossed metal tag which is placed in a plastic bag and attached to the specific engine component. The WCD is a check list of process steps. All components and subassemblies can be matched to the appropriate engine or engine module through the use of the ITN. "The ITN is the key mechanism for tracking engine parts between the initial disassembly and final assembly processes" (Bertschmann, 1992:8).

The WCD and the metal tag travel with the engine component part through cleaning, overhaul, and assembly. Upon arrival at assembly, the components are returned to the appropriate engine.

The Problem. Manual entry of source data leads to a lack of timely and accurate data concerning location and status of particular items in the overhaul facility. As of the date of this research, it is estimated that only 50 percent of facility work is key-entered into the system (Bertschmann, 1992:12).

The Potential Solution. Kelly AFB is in the process of implementing an RFID system to assist in the real-time

collection of source data provided to ITS. "RF technology has been selected because it allows the transfer of information from a source (engine component) to a central management information system (ITS) without requiring physical contact with the source or human intervention" (Bertschmann, 1992:8). The RFID system will consist of RFID tags, interrogators, two PCs, existing fiber optic cables between the buildings, and new dedicated communication networks for the interrogators in each building. The RFID tags are attached to engine components during overhaul processes. RFID interrogators are scattered strategically throughout the four buildings to provide total RFID coverage of the facility. These interrogators gather data as the tags move with the engine components through the facility and pass that data to the special data collection PC. The PC collects the data communicated from all interrogators, stores the data locally for remote output, and then transfers the data electronically to the ITS computer (Bertschmann, 1992:16-20). There are four key objectives for the RFID system:

> (1) Provide the capability to accurately track the total test population of engine components moving through the overhaul facility by ITN, location and date/time.
> (2) Integrate the proposed system solution into current operations, the existing interbuilding communication network, and Inventory Tracking System (ITS).
> (3) Minimize the impact of the proposed system solution on current operations, the existing communication network, and ITS.
> (4) Where possible, automate the functionality of the proposed system solution, thereby minimizing dependency on manual key entry input. (Bertschmann, 1992:13)

During the induction process, instead of using the plastic bags to hold the paperwork, a specially designed pouch containing an RFID tag, the metal tag, and the WCD will be used. The RFID system will provide visibility of all tagged components in the facility. When the engines are reassembled their ITNs are retired/archived and the RFID tags are erased/decommissioned for used on another engine component.

Training. Formal and informal training are integral to this advanced technology project. Early in the project, the project manager at Kelly AFB, was provided formal training on the SAVI RFID system at the contractors facility in Palo Alto, California. During this training the project manager became familiar with TAG Operating System (TAGOS), the RFID operating system, and the inherent capabilities of the RFID system. Once the system is installed and has met the requirements of the acceptance test, formal training of the floor supervisors is planned. Formal training of the project manager on the RFID system as well as the transfer module between the RFID system and ITS is also planned. However, no formal training of the overhaul line workers is scheduled. Instead a SAVI representative will spend two weeks walking through the overhaul facility discussing the capabilities of the system with line personnel and answering questions.

Structured Survey Results

This section reports the results of the structured interviews administered to those individuals responsible for the implementation of RFID at the engine overhaul facility at Kelly AFB. These individuals include: the contractors, the government technology staff, the upper management at Kelly AFB, the RFID project manager at Kelly AFB, and the overhaul line workers at Kelly AFB. Each common element of the aggregate model is addressed from the perspective of the group interviewed.

Table 4.1 provides a summary of the scaled interview results. The mean of the various questions for each element were used to gauge the respondent's view of the importance of each element. A mean of the numerical responses to each of these questions was computed and represents the importance of each element to each group. Where the sample sizes were larger than one, the numerical responses of all respondents in each group were used to calculate the mean for each element. The rotated bar charts in the following sections graphically depict each group's mean response to the importance of each element.

Sample Description. As expected, the contractors were represented by a sample size of four; MITLA, upper, and middle management were represented by a sample size of one each; and the workers were represented by a sample size of eleven.

TABLE 4.1. RESULTS OF SCALED INTERVIEW RESULTS.

Element	Contractor	MITLA	Upper Mgt	Mid Mgt	Worker
Info Avail	6.7	7.0	7.0	6.2	6.4
Antic Profit	5.3	7.0	7.0	5.0	6.4
Prob of Success	6.4	7.0	7.0	7.0	6.7
Polit Attitude	7.0	7.0	7.0	5.0	6.5
External Pressure	6.3	7.0	3.0	5.0	5.8
Teamwork	5.9	7.0	7.0	2.0	6.8
Strat Planning	6.5	7.0	7.0	6.0	6.8
Resource Avail	6.8	7.0	7.0	6.3	6.7
Training	6.5	7.0	7.0	6.2	6.6

Unfortunately, the RFID project was behind schedule and was not installed prior to the researcher's site visit to the engine facility at Kelly AFB. As a result, workers were not informed of the RFID project and could not adequately respond to portions of the questionnaire. Therefore, a non-probability census was also the method of data collection for the worker group and t-tests were not accomplished as proposed in Chapter III.

Table 4.2 summarizes the demographic data of the respondents. Four demographic items were asked of each person interviewed: age, gender, rank/position, and tenure with the organization or firm. The sample size of each group is also included in the table. The mean age of the

TABLE 4.2. SAMPLE DEMOGRAPHICS.

Sample Group	Group Size	Mean Age (Years)	Males	Females	Mean Grade/ Position	Tenure (Years in Org)
Contractors	4	47	3	1	Pres/VP	9
MITLA *	1	37	1		GS12	2
Upper Mgt *	1	40	1		GM13	1
Proj Mgt *	1	30	1		GS12	8
Workers	11	40	9	2	WG/L8.5	10

* Sample size of one represented the population

people interviewed ranged from 30 years for the project manager to 47 years for the contractors. Of the 18 people interviewed, 3 were female and 15 were male. The four contractor personnel interviewed were either the president or a vice president of their companies. Government employee mean pay grades ranged from WG-8 for the workers to GM-13 for the Kelly Engineering Section chief. Assuming a twenty year government retirement, it is not surprising to see mean organizational tenures ranging from one to ten years.

<u>Information Availability</u>. There were five questions in the survey which gauged the importance groups placed on the availability of information. Information has different meaning for each of the groups interviewed. These

differences are discussed in the following paragraphs for each group participating in the RFID implementation. The group's response to the importance of information availability are summarized in Figure 4.2.

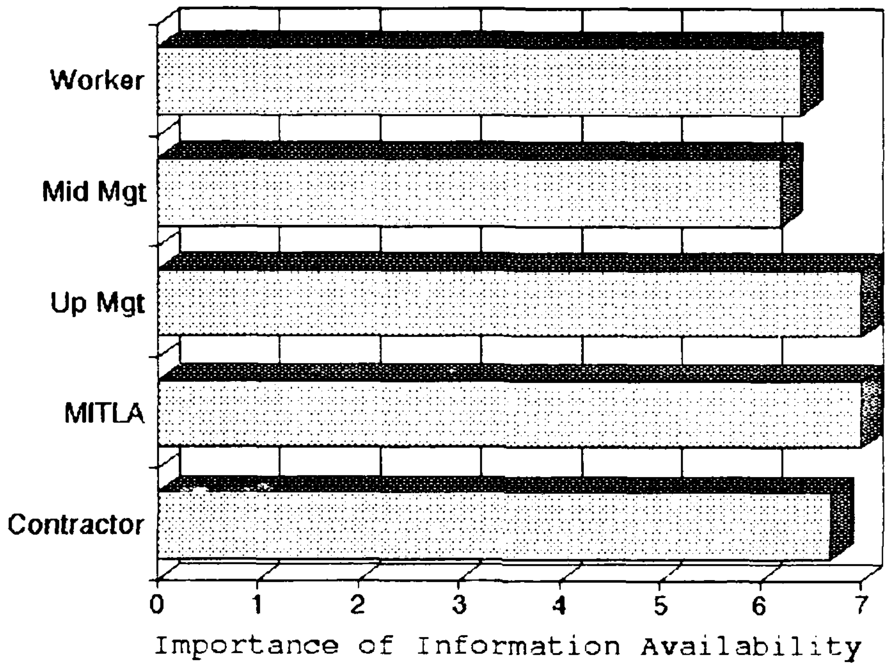

Figure 4.2. Importance of Information Availability Across Project Management Levels.

Contractors. The RFID technology contractors, SAVI Inc., as well as the integration contractors, Applied Systems Institute (ASI), viewed the availability of information as between important and very important. SAVI was responsible for the RFID system. ASI was responsible for transferring the RFID systems information to the existing ITS system. Information, in their view, represented the requirements of the project. Neither

contractor felt that the requirements were well defined in the contractual Statement of Work (SOW). Three separate visits to Kelly AFB and numerous telephone calls were required to finalize the requirements of the project. ASI, collected, consolidated, and reported monthly status to the individuals and organizations involved in the RFID project. ASI suggested that the client (Kelly AFB) was not informed as to the capabilities of RFID. The contractors agreed that an on-site requirements determination visit early in the project was critical.

MITLA Office. The MITLA office is a government technology office responsible for overseeing the implementation of microcircuit based AUTO ID technologies throughout DOD and the AF. Information availability was very important to this office. Information from both the contractors and Kelly AFB was consolidated into a marketing presentation and demonstration which was provided to senior management at the jet engine overhaul facility. Information in the monthly reports was used to monitor the progress and financial status of the project. The reports highlighted the facts that the project implementation schedule was extended to allow for development of tag launch stations and that the project did not surpass projected costs.

Upper Management. The branch manager at the jet engine overhaul facility at Kelly AFB has been in this position for six months; therefore, he was not involved in the initial stages of the project. However, based on his

previous experience, the branch manager advised that the availability of information is very important for an advanced technology implementation. His management style consisted of a "hands-off" approach with his competent engineers. Informal, sporadic project status was provided to the branch manager by the project manager as problems and concerns arose. The formal monthly status reports by ASI were not forwarded to the branch manager by the project manager.

Project Manager. The project manager at Kelly AFB viewed the availability of information as important. This individual was involved with this project from its inception. After the SOW and initial site survey reports, the monthly status reports provided by ASI were not very useful. From his view, the reports concentrated on the financial aspects of the project and addressed issues he was already aware of and working. His information source consisted of open communications between himself and the other organizations involved. The information desired by the project manager included the status of technical difficulties and the final installation schedule.

Overhaul Line Worker. The eleven individuals interviewed from the overhaul line felt that information availability was between important and very important. Instead of the details of the project, they sought information about how the project would affect them and how they do their job. Two of the eleven interviewed had prior

knowledge of the project. These two individuals were personal friends with the project manager and obtained their information through informal contact. The other workers learned about the project during the structured interview. At the conclusion of the interview, all of the workers expressed an interest in pursuing more information about the project.

Analysis of Information Availability. All of the groups interviewed rated the importance of information availability to successful implementation between important and very important. Surprisingly, the lowest rating came from middle management (the project manager). He was responsible for the technical aspects of the implementation and would have been more interested in additional technical information. He felt that the additional information provided in status reports was primarily financial and not as useful to him. The highest ratings came from MITLA and upper management (the Engineering Section chief). MITLA was the central nerve center for the project and would, necessarily, be interested in obtaining as much information as possible about the status of the project's progress. Likewise, upper management would be interested in receiving good information on the progress of the project so he could keep his finger on the pulse of the project. These differences were very subtle. All groups saw information availability as important.

Anticipated Profitability. Profitability for this study is the cost of the implementation as compared to the monetary and intangible benefits of employing the advanced technology. ASI is scheduled to complete an Economic Analysis (EA) in accordance with the RFID implementation contract. Each group's response to the importance of anticipated profitability in implementing new technologies are summarized in Figure 4.3.

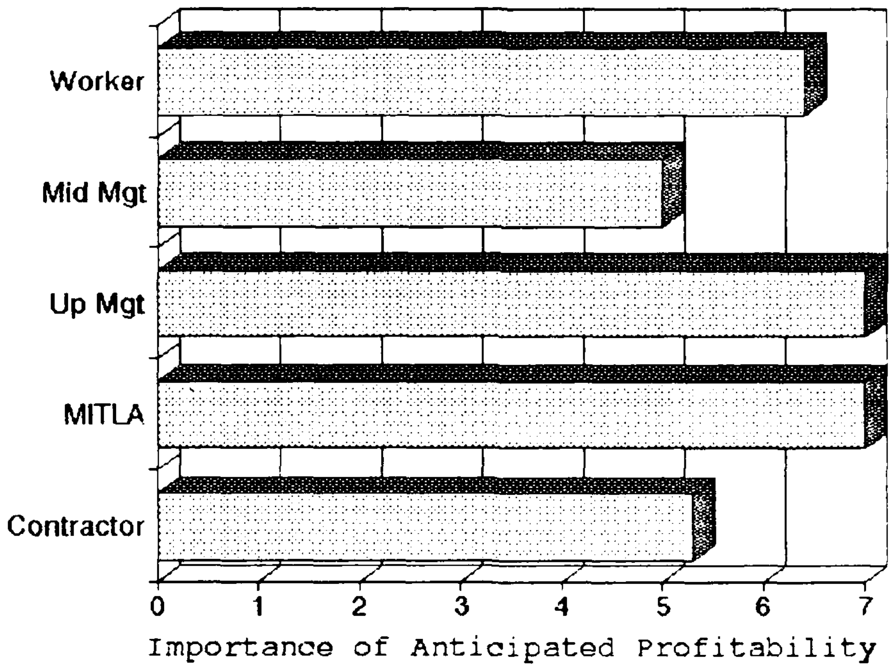

Figure 4.3. Importance of Anticipated Profitability Across Project Management Levels.

Contractors. The contractors interviewed felt that predicting the profitability was important, but that an EA may not be necessary for every advanced technology implementation. Advanced technology implementation may have

multiple goals. For the military, goals may be focused on productivity during peace time and focused on war-fighting capability during war time. EAs may be very important during peace time and slightly unimportant during war. The contractors stated that in the short run, as during the prototype phases, an EA prior to implementation is slightly unimportant because the project focus is the testing and evaluating of the prototype performance rather than the documenting of economic benefits. However, in the long run, when attempting to export the project to other similar areas, an extensive EA is very important. According to the contractors, an EA for this project does not show success on the original project, rather it identifies areas of potential savings. Prototypes test concepts and new procedures as well as advanced technology.

MITLA Office. The individuals interviewed indicated that an EA is very important to the success of an advanced technology implementation. Although not accomplished prior to the selection or implementation of the RFID system, an EA is scheduled after the acceptance test to evaluate if the prototype should be exported to other similar applications. Prior to the project start, the MITLA office estimated, based on its experience with the technology, significant costs savings in personnel and inventory accountability.

Upper Management. Because of this supervisor's newness on the job, he was not aware if an EA was

accomplished for this project. However, based on his experience with other advanced technology projects, an EA is very important and tied to securing complete funding for the project. He perceives that future funding is tied to a positive EA. Based on his knowledge, the project appears to be cost justified because of the potential that the major problem of inventory tracking will be eliminated.

Project Manager. The project manager at Kelly AFB advised that an EA was not accomplished for the RFID project and that it was slightly important for the success of the project. The project manager is usually shielded from some of the funding issues which may have caused a lower rating of this element. His focus was on the technical issues with the project. Although he felt the project was cost justified, based on his knowledge of the technology, he did not think cost justification was as significant to this project as with some of the other projects.

Overhaul Line Worker. The line workers indicated that an EA should be accomplished prior to implementation and placed its importance between important and very important for the success of the project. One of the workers who had prior knowledge of the project, viewing the project from an operational standpoint, suggested an EA was neither important or unimportant. Another worker suggested that cost justification is not as important as insuring people use the system properly. The worker's focus was on operational issues rather than on profitability.

Analysis of Anticipated Profitability. The group ratings of the importance of considering the anticipated profitability of a project ranged from slightly important to very important. The interviewees were divided into three ratings. Contractors and the project manager rated this element as slightly important, the workers rated it as important, and MITLA and upper management rated it as very important. Contractors and the project manager were more interested in making sure the project solved the data collection problem rather than contributed a profit. RFID tracking is a new technology to the military and the contractors want it to work at the engine facility so other potential applications will be exposed. Due to the production versus profit emphasis in the overhaul facility, the project manager will reap more rewards in the form of promotions and pay increases by solving the tracking problem than by providing a profit. MITLA and upper management would rate this element as very important because they see profitability in terms of benefits to the organization instead of financial profits. Profit is a difficult concept for a non-profit organization such as the AF.

Probability of Success. There were two questions in the survey which gauged the importance of investigating the probability of success prior to implementation. Each group's response to the importance of the probability of success in implementing new technologies are summarized in Figure 4.4.

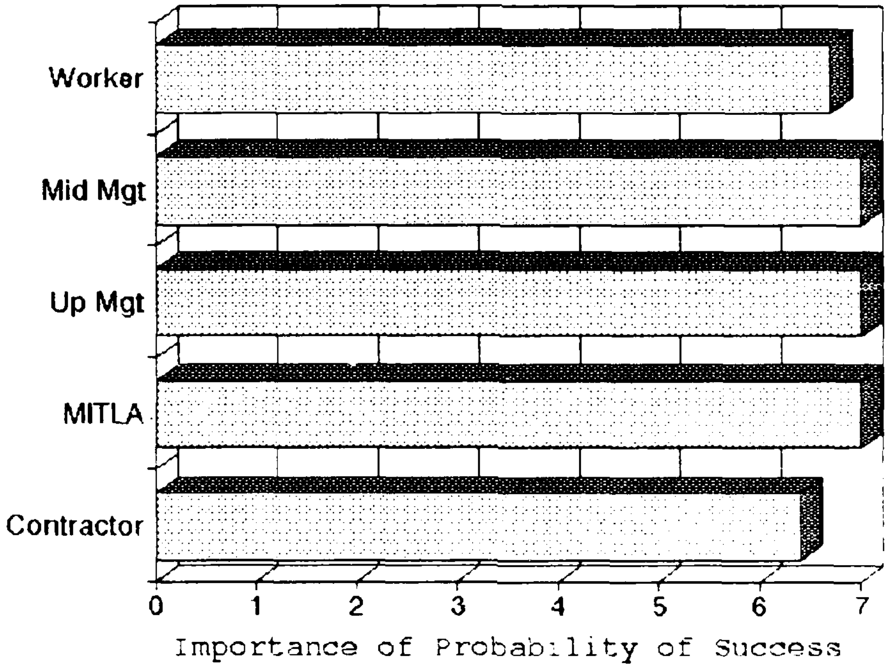

Figure 4.4. Importance of Probability of Success Across Project Management Levels.

Contractors. The contractors indicated that investigating the probability of success of alternative technologies is between important and very important to the success of advanced technology implementations. SAVI contractors were aware that alternative technologies were investigated for this project, but ASI contractors were unaware that alternatives were sought by Kelly AFB. ASI made the distinction that for smaller projects, such as the engine facility at Kelly, investigating and ranking alternative solutions is slightly important; whereas, for larger projects, investigating alternative candidates is

very important. The search for alternatives provides confidence in the final selection and usually focuses the requirements of the project. When investigating alternatives, SAVI suggested that the goals are slightly important and user expectations are very important and should be monitored and managed.

MITLA Office. This individual suggested that investigating and ranking alternative technological options was very important to the success of the project. He advised that the overhaul facility at Kelly AFB was using barcode technology with limited success.

Upper Management. This supervisor was aware that alternative technologies were investigated by his staff. Based on his experience with other advanced technology implementation, investigating alternative technologies was very important to the success of the project to ensure user requirements are met.

Project Manager. Success for the project is defined by the project manager in terms of location and inventory accuracy. In this case, the ITS users expects RFID to enable them to locate and inventory parts with 95 percent accuracy. Having initiated and led the investigation for alternative technologies to solve the ITS data collection problem, this individual advised that investigating alternative technologies is very important to the success of the project.

Overhaul Line Worker. The line workers interviewed proposed that investigating alternative technologies, based on their experience, was between important and very important for the success of the project. Only one worker had knowledge that alternatives were investigated. One worker assumed that alternatives were investigated and ranked. Success for several workers was described as seeing a recoupment of project costs, reducing transaction time, making the new system user friendly, and requiring less interaction time with the system by the line workers.

Analysis of Probability of Success. All of the interview groups rated the importance of evaluating the probability of success of alternative solutions between important and very important. The contractors rated this element closer to important than to very important. Contractors are interested in selling their technology, so they would be less concerned with other alternatives. They would want to make their solution appear to be the best alternative. Managers and MITLA, on the other hand would want to search for the alternative that best meets their needs and stands the best chance of succeeding.

User Attitudes. The structured interview did not contain scaled questions for this element. The questions were intended to gauge the respondent's first impressions of the project and impressions at the time of the interview.

Contractors. This element was eliminated from the contractors structured interview because the contractor could not respond as a user for this project.

MITLA Office. This element was eliminated from the MITLA office structured interview because, as the liaison between the contractor and the user, this organization could not respond as a user for this project.

Upper Management. The RFID project was initially viewed as an improvement in SA-ALC's capabilities by upper management. However, the government authorized delays in implementation caused anxiety.

Project Manager. The project manager expressed cautious optimism when first presented with the project. Over time, he became more convinced that the project will succeed based on additional information and a trusting relationship built with the contractors.

Overhaul Line Worker. The line worker's first impression of the project coincided with the structured interview. Many of the workers indicated that the project seemed promising, but that they needed more information before making a final determination. Others saw the delay in implementation as an understandable negative influence, but were anxious to implement. One worker suggested the proposed system sounded better than the current system. One worker expressed some skepticism about the project. His feelings were based on his feeling that many previously-implemented systems did not succeed in their intended goals.

Analysis of User Attitudes. When the project was first introduced to the project manager and line workers, their lack of knowledge concerning this advanced technology caused skepticism and a wait and see attitude. As more RFID technology knowledge was absorbed by the project manager and project information absorbed by the line workers, a more positive attitude was displayed. However, delays in implementation caused anxiety and a reduction in confidence that the system will meet the expectations of the overhaul facility personnel.

Political Attitudes. There were three questions in the survey which gauged the importance of political attitudes as a factor in the successful implementation of advanced technology. Political attitudes were described to the interview groups as the necessity for management to communicate the benefits of the proposed project to the working level. Each group's response to the importance of political attitudes in implementing new technologies are summarized in Figure 4.5.

Contractors. The contractors unanimously agreed it was very important for management to communicate the benefits of the proposed technology change to the workers who would be affected. They perceived that this project was voluntary for the project manager, but was mandatory for the line workers. The user should be brought in from the beginning of the project. ASI indicated they have not interfaced directly with the users. The user needs to be

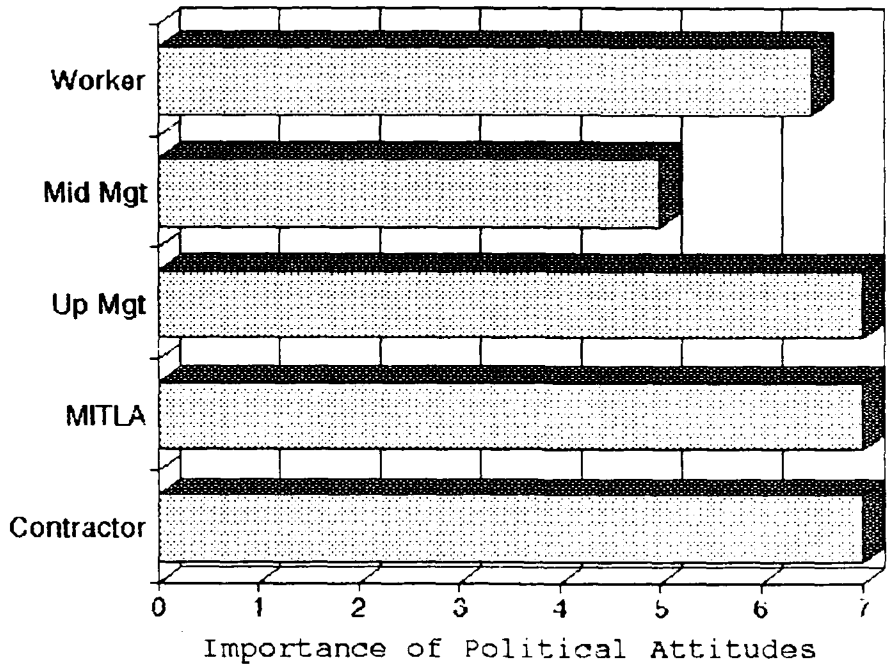

Figure 4.5. Importance of Political Attitudes Across Project Management Levels.

convinced that this advanced technology is not "big brother". Many of the benefits of the RFID system will be communicated during the training sessions.

MITLA Office. The MITLA office shared the contractor's view that communicating the benefits of the proposed technology change to the workers is very important. The individual interviewed indicated that the project was voluntary for Kelly AFB. The goals of this office are to implement an advanced technology, state-of-the-art inventory and tracking system.

Upper Management. The individual interviewed advised that it was very important for management to

communicate the benefits of the advanced technology to the workers. From his perspective, the goal of the organization was to produce a timely, quality product at the lowest costs. He felt this project would promote more efficiency with less manpower.

Project Manager. The project manager at Kelly AFB ranked political attitudes as slightly important for this project. He stated that the user is not impacted by this implementation and is not directly involved in locating parts. An underlying objective of the project according to the project manager is to remove the human element from the process. The project manager sensed pressure from upper management to implement an alternative technology (infrared tagging system). The overall goal of the project was to improve the data accuracy within the ITS system.

Overhaul Line Worker. The line workers asserted that it was between important and very important for management to inform them concerning the benefits of the proposed new system. Many expressed a "wait and see" attitude toward the project. The goals of the organization voiced during the interviews included: production of overhauled engines, quality product at a good price, better handle on inventory, reduced costs, supply information required by the user, and customer satisfaction.

Analysis of Political Attitudes. The project manager (middle management) was the only one that rated the importance of political attitudes to the success of a

project less than important; he rated it as slightly important. He rated it so low because he felt that since the RFID implementation was transparent to the workers, there was no need to convince them that RFID would benefit the worker. Conversely, the contractors, MITLA, and upper management rated this element as very important. These staff-level individuals understand the importance of securing up-front user support for a new technology implementation. It is evident in the worker's rating (between important and very important) that they were wanted more information about how the system will affect them.

External Pressure. There were three questions in the survey which gauged the importance of external pressure on the organization as a success factor in implementation of advanced technology. Each group's response to the importance of external pressure in implementing new technologies are summarized in Figure 4.6.

Contractors. The contractors viewed external pressure as an important to a very important success factor. Neither of the contractors initiated this project, nor did they view themselves as a source of external pressure. One contractor suggested that the project was driven by internal pride and external pressures such as competition. Another contractor view implied that it was critical to have an individual as a champion of the project within the organization. The more influential and powerful the champion the greater the chances for success.

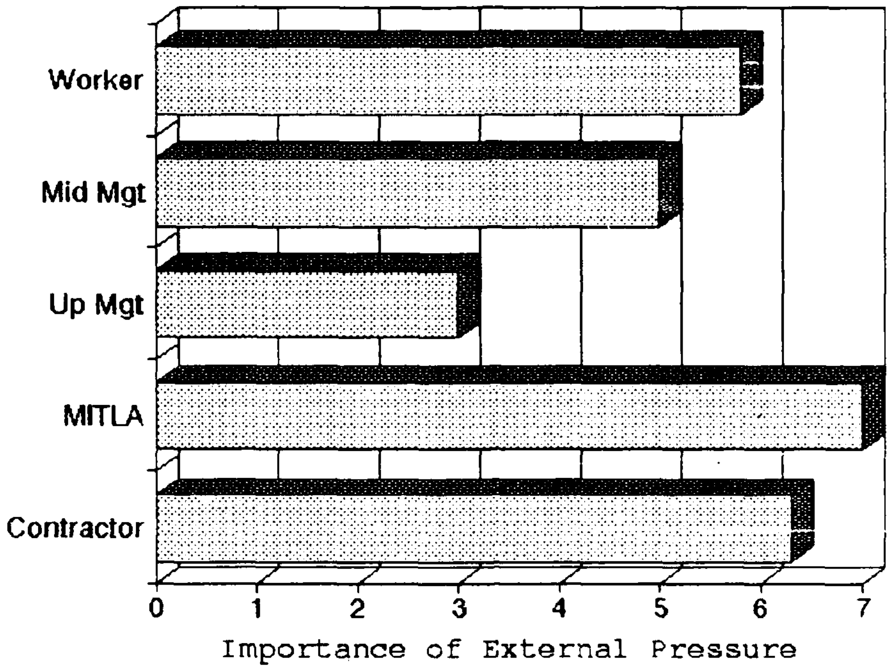

Figure 4.6. Importance of External Pressure Across Project Management Levels.

MITLA Office. The MITLA office viewed the external pressure as a very important success factor. The MITLA office viewed themselves as an external force in the RFID project since this organization introduced the capabilities of RFID to the project manager at Kelly AFB.

Upper Management. The section chief at Kelly AFB suggested that external pressure played a small, slightly unimportant role in the success of the project. Funding availability was the factor that caused his organization to search for alternative technologies.

Project Manager. The project officer viewed external pressure as slightly important. He felt since RFID

was proposed from outside the organization, his view of potential alternatives was broadened. Inventory accuracy was perceived as an internal threat that affected the external threat of workload competition with other depot facilities. The project manager usually viewed external pressure as negative because it usually carries power by authority rather than power through respect. However, external pressure according to the project manager, did not make a difference in this project.

Overhaul Line Worker. The workers on the overhaul line suggested that external pressure was between slightly important and important as a success factor. They saw workload competition with other Air Force, DOD, and contractor depots as the major external pressure driving the RFID project.

Analysis of External Pressure. The importance of external pressure to the success of a project was rated from slightly unimportant to very important. Opinions about external pressure varied significantly between the groups. It stands to reason that upper management provided the lowest rating for this element. Upper management felt that his people would work to make any project succeed, regardless of where it was initiated. The project manager rated this element more important than upper management, but still on the low side of important. He had the same confidence in his people, but was closer to the pressure. He was in a position to feel more of the heat from external

sources to make the project succeed. The workers rated this element as important. The working level is at the bottom of the pressure funnel. They feel that they are forced into making a project work if there is a great deal of external pressure. They will work to make it succeed even if they have to manipulate variables to make it appear that the system is working. MITLA rated external pressure as very important. Since they viewed themselves as a source of external pressure, they saw themselves as drivers in making sure this project succeeded.

Teamwork. There were two questions in the survey which gauged the importance of teamwork as a success factor in implementation of advanced technology. Each group's response to the importance of teamwork in implementing new technologies are summarized in Figure 4.7.

Contractors. The contractors agreed that a team existed for the implementation of this project and that a team approach was between slightly important and important for a successful implementation. The responsibilities of each team member were documented in a technical memorandum. One contractor stated that, depending on the make-up of the team, some projects may be more suited for an individual effort than for a team approach. When teams collectively work together, projects enjoy success. However, when teams fail to work collectively the project suffers.

MITLA Office. MITLA office personnel perceived the team approach as very important to the success of the

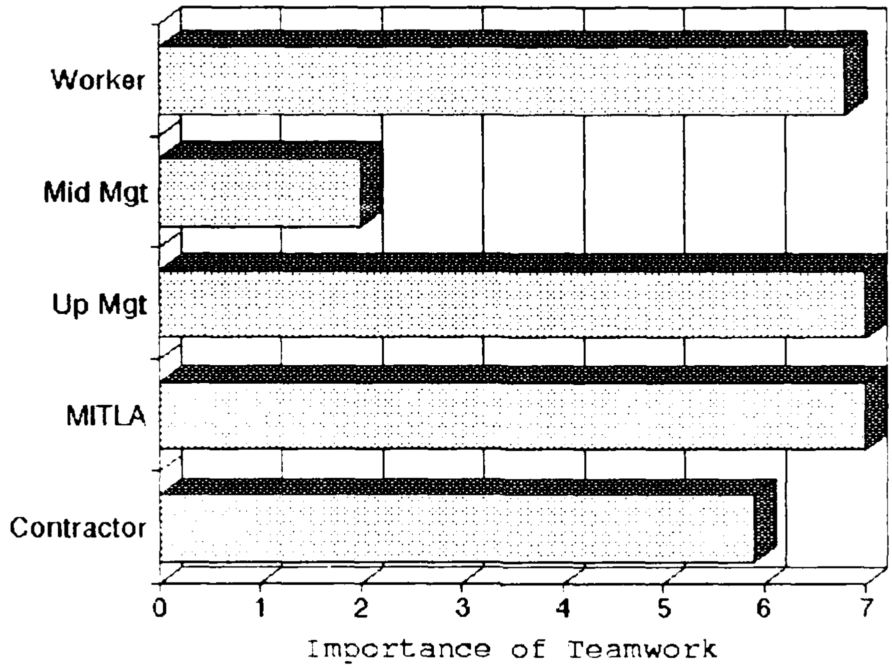

Figure 4.7. Importance of Teamwork Across Project Management Levels.

project. They felt that an implementation team was formed and that a person from their office was a member of that team. Other team members included one person from each contractor and the project manager.

<u>Upper Management</u>. The section chief at Kelly AFB suggested that teamwork was very important to the success of the project, but added that there was no implementation team created at the engine facility. He saw his project manager as the individual responsible for the successful implementation of the RFID system.

<u>Project Manager</u>. The project manager did not view himself as a member of an implementation team. He stated

that teamwork was unimportant as a success factor in this project. He saw this project as one in which he held the responsibility for its success or failure and a team was not necessary.

Overhaul Line Worker. The line workers were not aware of the existence of an implementation team. However, they felt it was very important for an implementation team to manage the implementation. Many of the workers expressed an interest in membership on the implementation team.

Analysis of Teamwork. The groups rated the importance of teamwork in implementing technologies from unimportant to very important. This element was the one in which the opinions of the groups varied the most. The project manager provided the lowest rating for this element; he rated it as unimportant. He did not perceive that there was a team developed to work on this project, but saw the project as succeeding. As a result, he did not see the importance of using a team concept. Upper management expressed the same feelings about the lack of a team for this project, but, as most managers would feel, felt it was very important for most projects. The contractors rated this element as important stating that there are some projects that are better suited to individual efforts rather than team efforts. Again, the workers had a strong desire to be involved in the project and be a part of the implementation team. They rated the teamwork element as very important. Likewise, MITLA rated teamwork as very

important. This rating is due to the fact that MITLA personnel viewed themselves as part of the team. They saw their involvement as critical to the success of the implementation. The recent government-wide mandatory Total Quality Management (TQM) training, the participation of government personnel on Process Action Teams (PATs), and team building training may have elevated the importance of teamwork for the government respondents.

Strategic Planning. There were two questions in the survey which gauged the importance of strategic planning as a success factor in implementation of advanced technology. Each group's response to the importance of strategic planning in implementing new technologies are summarized in Figure 4.8.

Contractors. The contractors determined that strategic planning was important. They were aware of the overhaul facilities short-range goal of productivity enhancement, but were unaware of the long-range strategic goals of the engine overhaul facility. The contractors felt the RFID project would meet the short-run goals of the overhaul facility.

MITLA Office. The MITLA office perceived that the existence of strategic goals was very important to the success of the project, but were not aware of the specific strategic goals of the overhaul facility.

Upper Management. Upper management at Kelly AFB stated that the existence of strategic goals was very

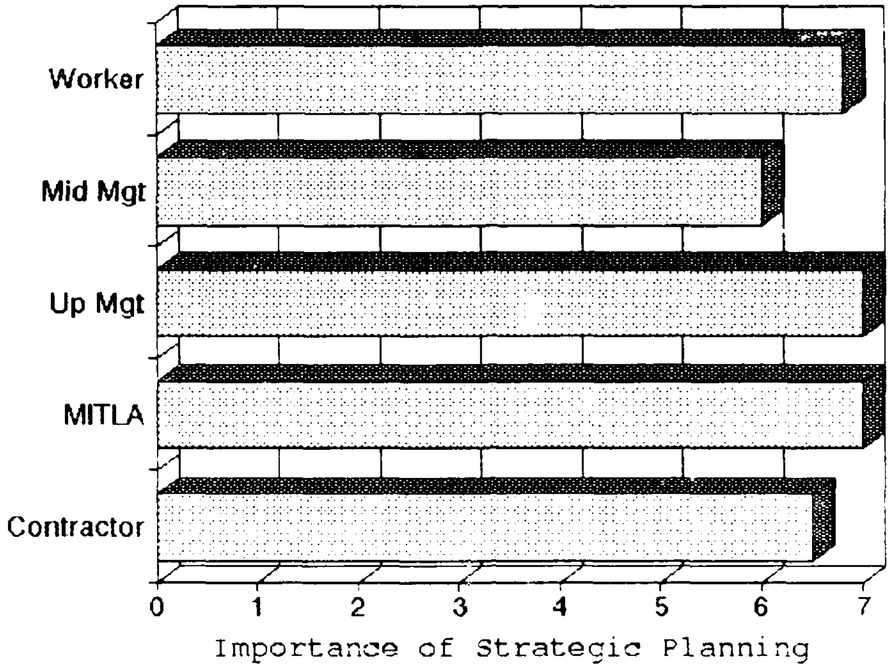

Figure 4.8. Importance of Strategic Planning Across Project Management Levels.

important to the success of the project. Since strategic planning is an upper management responsibility, this response was not a surprise.

Project Manager. The project manager indicated that the existence of strategic goals was important to the success of the project, but was not directly involved in strategic planning.

Overhaul Line Worker. The workers on the overhaul line perceived that the existence of strategic goals was just short of very important to the success of the project. Several workers expressed the "wait and see" attitude toward upper management's ability to plan long range.

Analysis of Strategic Planning. All of the interview groups rated the importance of strategic planning to the successful implementation of technologies between important and very important. The project manager rated strategic planning the lowest of the five groups because he is insulated from the strategic planning process. Although the workers are also insulated, they rely on senior management to develop successful strategic goals. The recent mandatory viewing of General McPeak's Vision Video which provided an overview of the AF strategic goals may have also influenced/elevated the responses for AF respondents.

Resource Availability. There were four questions in the survey which gauged the importance of available resources for a successful implementation of advanced technology. Resources included funding, manpower, and time. Each group's response to the importance of resource availability in implementing new technologies are summarized in Figure 4.9.

Contractors. The contractors indicated that overall resource availability was very important for the success of this project. One contractor viewed manpower and time resources as important, but not "show stoppers." Extensions and overtime are viable options to shortages in these areas. One contractor indicated that the initial time schedule was grossly underestimated because of vague requirements.

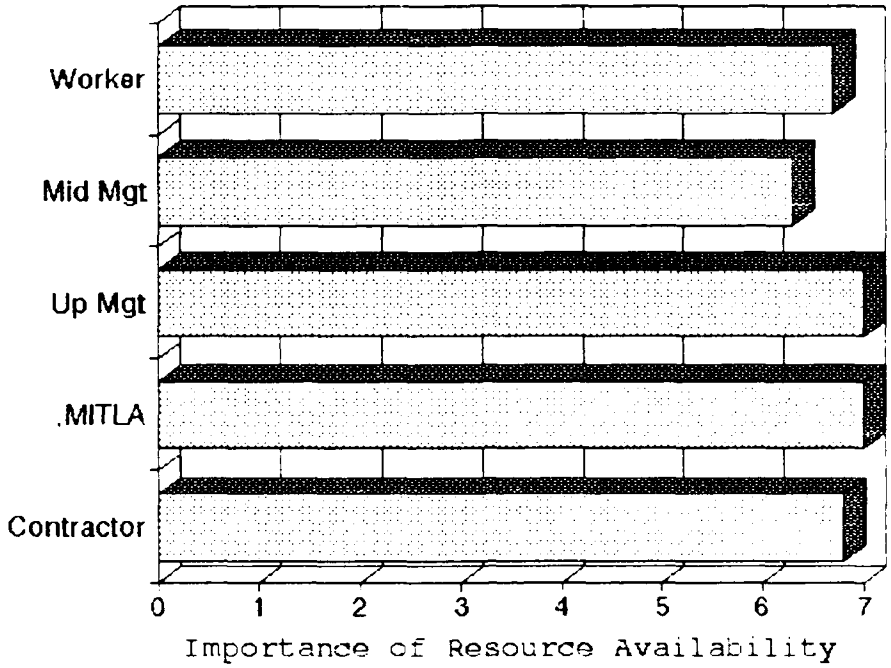

Figure 4.9. Importance of Resource Availability Across Project Management Levels.

MITLA Office. The MITLA office assessed resource availability as very important for the success of the project. They viewed the funding as adequate since they provided the funding for the project.

Upper Management. The section chief felt that resource availability was very important to the success of the project. He agreed with the contractor that manpower and time resources are relative and usually fixed. A manager must maximize the utilization of the resources which are available.

Project Manager. The project manager stated that resource availability was important. He viewed financial

resources as very important and manpower and time as important to the success of the project.

Overhaul Line Worker. The line workers were not aware of the funding decisions related to this project but suggested that adequate resources were between important and very important for this and other advanced technology projects.

Analysis of Resource Availability. All of the interview groups rated the importance of resource availability to the success of a project between important and very important. Resource availability was more important to staff organizations such as the MITLA organization and upper management because they maneuver for project funding. The other organizations such as the line workers and project officer use the funding but have little input into the bureaucratic funding process.

Training. There were five questions in the survey which gauged the importance of available resources for a successful implementation of advanced technology. Each group's response to the importance of training in implementing new technologies are summarized in Figure 4.10.

Contractors. The contractors indicated that training was important for the success of the project. Off-site training at SAVI was accomplished for the project manager and staff. This training familiarized the trainees with the systems and capabilities of the RFID system. SAVI stated that a "buy-in" by the users is necessary for the

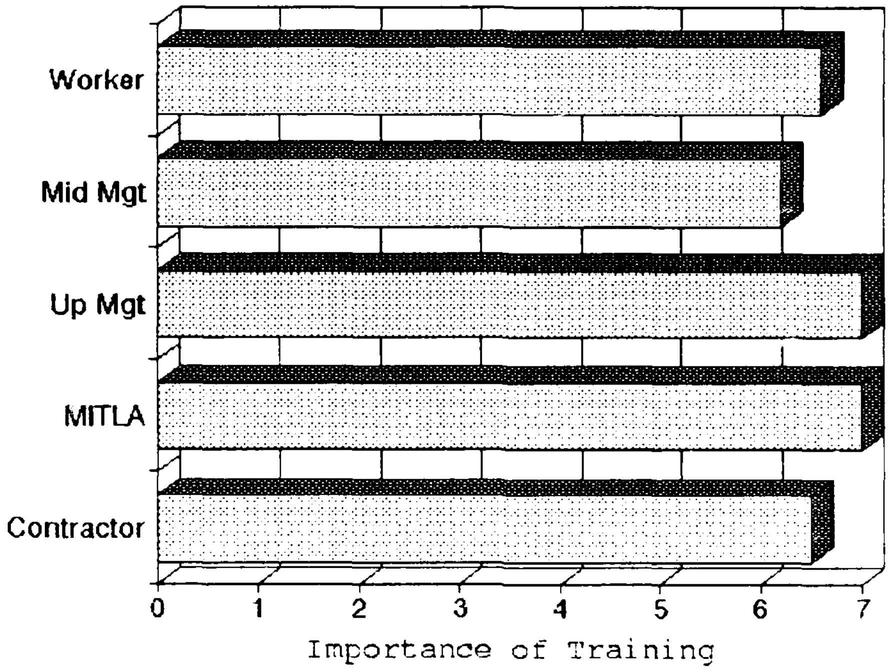

Figure 4.10. Importance of Training Across Project Management Levels.

project to succeed. Additional training is not anticipated because of the care taken by both contractors to provide a simple solution, which uses off the shelf hardware and software. ASI views maintenance of the system as key, rather than additional training once the system is operational.

<u>MITLA Office</u>. The MITLA office strongly supported training as a very important success factor in the implementation of RFID. This office placed specific training requirements in the contracts with ASI and SAVI.

<u>Upper Management</u>. Upper management at Kelly AFB is also committed to training and feels training is very

important to the success of the project. They have delegated the development and management of RFID training at the overhaul facility to the project manager.

Project Manager. The project manager perceives training as important for a successful implementation. He personally received training on the SAVI TAGOS. Because the system is not complex, the project manager feels that in-house training of the launch station and workcenter personnel will be sufficient. Although he will receive training on the RFID system, the project manager has reservations about some of the more complex tasks, such as tuning the antennas.

Overhaul Line Worker. The line workers felt that training was between important and very important for the successful implementation of technology. They all were anxiously awaiting familiarization training on the system.

Analysis of Training. All of the interview groups rated the importance of training to the success of a project between important and very important. The contractors viewed training in general as important, but for this project training will not be as intense of an effort as other more complex projects because of its simplistic design. The project manager rated this element the lowest of the five groups because he does not feel the RFID system affects the majority of the line workers. The workers felt training was important because it represents a source of

information concerning the project as well as a reduction in apprehension toward the project.

Chapter Summary

This chapter discussed the RFID data collection system employed at the jet engine overhaul facility at Kelly AFB, TX which included a description of: the engine overhaul facility, the Inventory Tracking System (ITS), the manual data collection process, the data collection problem, and the RFID solution. In addition to this case description, the structured interview results were reported and analyzed. Each of the aggregate implementation elements was discussed from each of the interview group's perspective.

Overview of Chapter V

The next chapter summarizes the research effort discussed in the previous four chapters. Conclusions and further discussions of analyses are then presented. Lastly, recommendations for future research in the area of advanced technology implementation are offered.

V. Conclusions and Recommendations

Introduction

This chapter reviews the issues presented in the previous chapters and provides recommendations and conclusions for the investigative questions posed in Chapter I. A recap of the research efforts presented in previous chapters is presented in the form of investigative question insights and conclusions followed by recommended implementation guidelines. The final area discussed in this chapter is the recommendation for future research.

Issues Reviewed

Recall that the purpose of this research was to examine an implementation of advanced technology and determine to what extent this application paralleled theoretical models for technology implementation. The first step in this study was to review the technological implementation literature and document the portion of that literature that was applicable to this research. With the review complete, the next step was to create an aggregate model based on the significant elements of the theoretical model identified in the literature review. The third step was for the researchers to travel to Kelly AFB and interview people involved in the implementation of RFID in the engine overhaul facility. The researchers also conducted some

telephone interviews. The results of the data collection process were then analyzed.

Case Study Environment

Before discussing the conclusions of this research, the nature of the environment at the jet engine overhaul facility at Kelly AFB is examined. This explanation provides a framework for the conclusions and recommendations.

The first characteristic of the environment is that the technology implementation at Kelly AFB was planned versus unplanned. The project was planned and initiated internally by the ITS system staff and supported and encouraged by the MITLA organization and contractors. Another characteristic is that RFID technology is a proven technology for several applications, but not for inventory status and location in a jet engine overhaul facility. The researchers assessed the risk of failure for the overall project as moderate since RFID is used for a new application. The RFID system will have little effect on the overhaul process. Third, the design of the system minimizes the impact to the line worker. Workers will interface with the system only at the launch stations. Fourth, the technical knowledge of the line workers is low, and the technical knowledge of the project manager is moderate. Finally, aside from the launch station, the RFID equipment is off-the-shelf; therefore, very little R&D was needed.

Conclusions and Insights

Investigative questions from Chapter I form the framework for the research. The conclusions and insights are discussed for each of the investigative questions.

Investigative Question One. What technology implementation models exist throughout industry? An extensive literature review revealed seven implementation models suitable for advanced technology. Each model was thoroughly described in Chapter II.

Investigative Question Two. What are the key variables/characteristics of each model and what are the common implementation elements? Each of the seven models addressed specific, narrowly focused implementation elements with some overlap between models. The significant implementation elements were extracted from each model. An aggregate list of the significant elements was formulated. Elements in that list included: information availability, anticipated profitability, probability of success, political attitude, user attitude, external pressure, teamwork, strategic planning, resource availability, and training. Table 5.1 shows the common implementation elements and the individual implementation models in which they were a factor.

None of the seven models described in the literature review referenced all ten aggregate implementation elements. The largest number of aggregate elements in any one model

TABLE 5.1. AGGREGATE MODEL MATRIX.

Common Elements	McCardle & Oliva Model	Equity Implementation Model	TEP Model	Lewin's Change Model	Corbitt and Norman	ADVANTIG	Levi Strauss
Information	X			X	X	X	X
Profit	X		X				X
Probability of Success	X		X				
User Attitudes		X			X		
Political Attitudes			X		X		
External Pressure				X		X	
Teamwork						X	X
Strategic Planning						X	X
Resource Availability			X				
Training				X	X	X	X

was five. Two of the models, ADVANTIG and Levi Strauss, had five of the aggregate elements. Four of the five elements appeared in both models.

Information availability was the most common aggregate element; five models referenced information availability. Training was the next most common aggregate element; four models referenced training. Anticipated profitability, the third most common element, was referenced by three models. Probability of success, user attitudes, political attitudes, external pressure, teamwork, and strategic planning were each supported by two models. Resource availability was referenced by only the TEP model.

Investigative Question Three. To what degree did the RFID implementation at the Kelly AFB, F-100 Jet Engine Repair Center represent the aggregate technology implementation model? Were the recommendations of the models followed by Kelly AFB? What were the consequences/results?

As discussed in Chapters III and IV, a structured interview was administered to the groups participating in the RFID implementation at the jet engine overhaul facility at Kelly AFB. A small number of individuals and organizations were involved because of the relatively small size of this project. These groups included: the application and RFID contractors hired for this project, the AF MITLA technology office, upper management at the overhaul facility, the project engineer at the overhaul facility and

the overhaul line workers at the jet engine overhaul facility. Each of these groups were interviewed. As discussed in Chapter IV, a limited number of line workers were interviewed because of their lack of knowledge and involvement in the project. Although, this limited the statistical evaluation of the interview data, the descriptive information documented in Chapter IV was instrumental in the findings and conclusions of this thesis.

The structured interview assessed how well the implementation elements for the RFID application at the engine overhaul facility followed the implementation elements of the aggregate technology implementation model proposed in this thesis. The results were analyzed in Chapter IV.

Aggregate Model Element Conclusions. Table 4.1 provided the means for each group and aggregate element. Based on these figures, the researchers concluded that, on a macro level, the application of RFID at the jet engine overhaul facility at Kelly AFB generally supported the theoretical aggregate model purposed by this thesis. Individuals interviewed believed the elements of the aggregate model were important for the successful implementation of advanced technology. Some elements enjoyed more support, from either the literature review or case study, than did others. For instance, probability of success, resource availability, training, information availability, strategic planning, and political attitudes

were considered very important by the sample population. Anticipated profitability and teamwork were viewed as important. External pressure, the lowest rated element, was slightly important to the successful implementation of an advanced technology.

As discussed in Chapter II, the literature search revealed seven advanced technology implementation models. Each of these models focused on one or more of the aggregate elements. The level of support for each element was determined by the number of times that element was referenced in the literature. Chapter IV concentrated on how well each of the aggregate elements were supported in an actual advanced technology implementation. Tables 5.2 through 5.6 combine the information gathered from Chapter II with the information from Chapter IV. Each table illustrates how well the different elements of the aggregate technology implementation models were supported by both the literature and the application.

For each of these tables, the aggregate elements are listed in the first column followed by the number of technology implementation models discussed in Chapter II that supported each aggregate element. As discussed in Chapters II and III, an exhaustive literature search was accomplished to identify technology implementation models. The number in the second column reflects the support for each aggregate element from the literature review. The next column shows the aggregate element means from each interview

group shown in Table 4.1. To avoid confusion, the aggregate elements were ordered the same for each of the five tables. Next, the numeric values of the first column were transformed into high, medium, or low. Aggregate elements supported by four or five models were considered highly supported. Elements supported by three of the models were considered to have medium support. Elements supported by two or fewer models were considered to have low support. The fourth column is the transformation of the second column to high, medium, or low. Elements rated by the interview groups between 5.5 and 7.0 were considered highly supportive. Elements rated between 4.5 and 5.4 were considered to have medium support. Elements rated lower than 4.4 were considered to have low support.

Contractor Support for Aggregate Model. Information from the contractor's perspective focused on the requirements of the project. Through careful understanding and analysis of these requirements, the contractor assessed whether his or her company could perform the implementation tasks.

Also, the contractor analyzed the anticipated profitability of the contract rather than Kelly AFB's anticipated profitability or cost savings from the RFID implementation. The risk of failure, or probability of success was also assessed by the contractor given the documented requirements. Because the initial requirements for this contract were vague, the contractors relied on

TABLE 5.2. CONTRACTOR SUPPORT FOR THE AGGREGATE MODEL.

Element	Model's Support	Contractor Ranking	Adjusted Model Support	Adjusted Group Ranking
Information Availability	5	6.7	high	high
Anticipated Profitability	3	5.3	med	med
Probability of Success	2	6.4	low	high
Political Attitude	2	7.0	low	high
External Pressure	2	6.3	low	high
Teamwork	2	5.9	low	high
Strategic Planning	2	6.5	low	high
Resource Availability	1	6.8	low	high
Training	4	6.5	high	high

previous contracts with the government, relationships established with the individuals involved and the contractors risk assessment.

Although there was low support for political pressure by the models, the contractors viewed a buy-in by the users as critical to the success of the project. The contractor anticipated achieving a buy-in by the users at the end of the implementation during user training. The researchers concluded that, although the contractors have rated political attitude or user buy-in very important, the

placement at the end of the implementation will be less effective than at the beginning of the project. Although the contractors and project manager do not anticipate affecting the average line worker, early involvement of the line workers would have secured the user buy-in.

Because the contractors viewed themselves as external to the RFID implementation, they may have overrated the importance of external pressure. They must, therefore rely on a team concept for the implementation. Contractors must also rely on multiple organizations for approval, requirements, funding, and implementation.

Strategic planning was very important from the contractor's view because an advanced technology implementation has a better chance for success if the implementation supports a strategic or corporate goal. Related to strategic planning is the availability of funding, the life blood of a government contract. Based on the vague requirements documented in the contract, the contractor had to assess whether the funding was adequate to complete the implementation. The contractor was not involved in the resource availability process.

Training was also used to refine the requirements of the project. Since the project manager was not familiar with the capabilities of the technology, the contractors included familiarization training early in the project. This familiarization training reduced the risk of failure from the contractor's perspective by allowing the project

manager to understand the technology and refine the requirements of the project.

In summary, contractors are not always involved in the initial planning for an implementation. Their perspectives on the implementation begins when the government involves them. This could come as late as the request for proposal, when much of the preliminary implementation process is already complete. The contractor's main concerns are information availability, profitability, risk of failure, and resource availability.

MITLA Office Support for Aggregate Model. The MITLA office viewed all the aggregate elements as very important for the successful implementation of RFID. They monitored the status of the project from multiple facets which included funding, completion schedule, contractor performance as compared to the SOW, and technical as well as functional problems. They relied heavily on the interactive communications with the other participating members as well as the monthly status reports which documented financial and implementation status. A continuous flow of information from all participating implementation members was critical.

Profitability for the MITLA office was crucial for the MITLA organization's survival. Funding for additional projects will continue to flow to the MITLA office if the implemented projects continue to produce a significant cost savings for the AF. Thus, a requirement for an economic analysis was required under the terms of the contract.

TABLE 5.3. MITLA OFFICE SUPPORT FOR THE AGGREGATE MODEL.

Element	Model's Support	MITLA Office Ranking	Adjusted Model Support	Adjusted Group Ranking
Information Availability	5	7.0	high	high
Anticipated Profitability	3	7.0	med	high
Probability of Success	2	7.0	low	high
Political Attitude	2	7.0	low	high
External Pressure	2	7.0	low	high
Teamwork	2	7.0	low	high
Strategic Planning	2	7.0	low	high
Resource Availability	1	7.0	low	high
Training	4	7.0	high	high

As the proponent of RFID technology for the AF and the DOD, the MITLA office viewed probability of success from a functional rather than a technological viewpoint. RFID is a proven technology awaiting an appropriate implementation opportunity. The implementation opportunity is where the MITLA office judges success or failure.

As with the contractors, the MITLA office also viewed themselves as an external pressure, providing automated data collection solutions through the use of RFID. The success of an RFID implementati depends on how well the MITLA

office can communicate the capabilities of RFID to perspective users.

Since the MITLA office relies on other organizations for the implementation of RFID technology, teamwork is very important. In addition, the Total Quality Movement (TQM) in the AF, specifically team building, may have elevated the MITLA office's response to teamwork.

In summary, the MITLA office usually initiates the RFID implementation by informing a perspective user of the capabilities of RFID. Information and effective communications are critical for the MITLA office to monitor the project. The functional application instead of the technology is viewed as a risk factor.

Upper Management Support for Aggregate Model. Upper management's information for this project consisted of issues or problems communicated by the project manager. If the project was progressing well, no information was provided to upper management. Upper management felt the information provided was enough to ensure the project was proceeding as planned. The manager placed more importance on having high-caliber personnel work the project than on consistent flow of project related information. Senior management buy-in is as critical as user buy-in. This project appeared to have less upper management buy-in because of the hands-off management style preferred by the upper management individual interviewed. Other less passive

management styles may have different requirements for information.

TABLE 5.4.
UPPER MANAGEMENT SUPPORT FOR THE AGGREGATE MODEL.

Element	Model's Support	Upper Mgt Ranking	Adjusted Model Support	Adjusted Group Ranking
Information Availability	5	7.0	high	high
Anticipated Profitability	3	7.0	med	high
Probability of Success	2	7.0	low	high
Political Attitude	2	7.0	low	high
External Pressure	2	3.0	low	low
Teamwork	2	7.0	low	high
Strategic Planning	2	7.0	low	high
Resource Availability	1	7.0	low	high
Training	4	7.0	high	high

Although political attitude was very important from the upper manager's viewpoint, upper management did not communicate the benefits of this project to the line workers. Upper management has yet to inform the workers of the technology change and its affect on their jobs. Even though this change seems minimal from a managers viewpoint, upper management should inform the users.

In summary, upper management is managing personnel instead of projects. Important issues and problems which cannot be resolved by the project manager are brought to upper management for resolution. The upper manager, under TQM, has empowered the project manager to implement the project.

Middle Management Support for Aggregate Model. Monthly status reports that provided financial and general status were not important to the project manager. He required quick access to contractor, MITLA, and local personnel to resolve technical and functional issues with the project. Verbal communication was preferred because the project manager was usually deeply involved with the issue.

The project manager was more interested in functional performance of the RFID system rather than the financial benefits. The financial benefits may become more important when the overhaul facility converts to activity based accounting.

A plausible explanation why the project manager viewed probability of success as very important was that project manager's advancement opportunities may be dependent on the success of the associated project. Because of the hands-off management style of upper management, the project's success or failure is shouldered by the project manager. The project manager and the contractors share the most pressure and risk on this project.

TABLE 5.5.
MIDDLE MANAGEMENT SUPPORT FOR THE AGGREGATE MODEL.

Element	Model's Support	Middle Mgt Ranking	Adjusted Model Support	Adjusted Group Ranking
Information Availability	5	6.2	high	high
Anticipated Profitability	3	5.0	med	med
Probability of Success	2	7.0	low	high
Political Attitude	2	5.0	low	med
External Pressure	2	5.0	low	med
Teamwork	2	2.0	low	low
Strategic Planning	2	6.0	low	high
Resource Availability	1	6.3	low	high
Training	4	6.2	high	high

Political attitude was rated lower by the project manager than the other interview groups. Since the project manager was very close to the implementation area, he did not see the RFID project affecting the user. Therefore, he did not see the benefits of users involvement in the project. In this project, the lack of user involvement may be a liability. Uninformed users may see the project as a threat. They may subsequently resist the project based on this premise.

The project manager was shielded from external pressure by upper management. He was aware of competing workloads among the AF, DOD, and contractor facilities. However, he viewed most of the pressure for this project as internally generated. Higher-headquarter external pressure or guidance was viewed negatively.

The project manager acknowledged the involvement of other organizations in the implementation of this technology, but did not view the group as a team. At the local level he contacted affected organizations when necessary.

The project manager's view of strategic planning for this project was narrowly focused. The RFID project was perceived as a solution to the inventory and location accuracy problems in the local Inventory Tracking System (ITS). ITS was viewed as a competitive advantage for the overhaul facility. Available resources were very important to the project manager. The lack of funding for two alternative technologies for this project directed the projected manager to an RFID solution which was fully funded by the MITLA office.

The project manager viewed the familiarization training conducted at the contractor's facility as critical for the development of the implementation concepts for this project. However, user training was viewed as necessary, but not critical, once the project was implemented. The project manager felt the RFID implementation would not affect the

user. He underestimated a valuable source of user-based implementation knowledge.

In summary, the project manager may have experienced pressure to succeed because of the perceived importance of success for promotion. His centralized style works well with the hands-off style of upper management. Clashing management styles may adversely affect the project. He appears interested in focused functional success such as improved data accuracy rather than strategic goals.

<u>Line Worker Support for Aggregate Model</u>. Although the scores do not reflect the information gathered in the interview discussion, the line workers most often discussed the importance of information availability and training. Each of these directly involved the line worker. The line workers were not aware of the RFID project. Once the project was introduced they were inquisitive for more project details. Many expressed a wait-and-see attitude because they were out of the information loop.

The line workers had no knowledge of the anticipated profitability of the project, but envisioned that management had investigated the anticipated profitability and the probability for success. They also felt that management should sell the line workers on the benefits of the project prior to implementation. They viewed this buy-in as critical to the success of the project.

TABLE 5.6. LINE WORKER SUPPORT FOR THE AGGREGATE MODEL.

Element	Model's Support	Line Worker Ranking	Adjusted Model Support	Adjusted Group Ranking
Information Availability	5	6.4	high	high
Anticipated Profitability	3	6.4	med	high
Probability of Success	2	6.7	low	high
Political Attitude	2	6.5	low	high
External Pressure	2	5.8	low	high
Teamwork	2	6.8	low	high
Strategic Planning	2	6.8	low	high
Resource Availability	1	6.7	low	high
Training	4	6.6	high	high

Workload competition was viewed as the source of external pressure responsible for the initiation of this project. Even without the details of the project, the workers saw the management-directed change as a competitive edge. The researchers feel the recent TQM program in AFMC is responsible for the heightened strategic view of the workers.

In summary, the workers desired more information on the project and how it would affect them. They expressed a distrust of changes implemented by management. This

distrust could have been managed by involving the user in the project from the start.

Summary of Support for Aggregate Model. The models discussed in Chapter II presented the aggregate elements from a macro perspective. After analyzing the interview results, the conclusion is clear to the researchers that each of the aggregate elements was viewed from a different perspective from each of the interview groups. For instance, information can be viewed as requirements, status, problem solving or buy-in. Profit can be viewed as money made on a contract, increased performance, or productivity savings. Success can hold different meaning for the organizations involved. Contractors view success as successfully meeting the terms of the contractual documents as well as providing utility to the user. The government may measure success in term of return on investment, greater accuracy or the affect the change had on their job. External pressure was more important to the organizations viewing themselves as external to the implementation, including the line workers. Internal organizations were insulated from the external pressure. Each organization's perspective on each aggregate element must be understood and respected by all participating organizations for the project to be successful.

Based on this analysis, the aggregate model should be modified to reflect a model with more depth and breadth.

Each of the models found in the literature focused on only a few of the elements in the aggregate model. The results of the case study showed that each of these elements is important to the successful implementation of technology. The existing technology implementation models lack breadth in the number of elements analyzed. The existing models also lacked depth. They did not account for a change in perception at each management level. For example, each of the implementation groups measured success differently. The RFID contractor saw an opportunity to showcase RFID technology, push the RFID application envelop, and solve a data collection problem. The AF MITLA office viewed the project as the exploitation of MITLA technology and an opportunity to promote further RFID applications. Upper management measured success by whether the project was on budget and free of complaints about the existing system. The project manager attains success when the RFID system provides accurate location and inventory information to ITS. Finally, the worker considered a project successful if the new system reduces employee workload, is easier to use, and effectively interfaces with the old system. The user also weighs the benefits of the system with the additional burden. These differing measures of success must be identified and addressed early in the project, nurtured, and monitored during implementation.

<u>Investigative Question Four</u>. What elements if any were incorporated in the case study RFID implementation, but were

not included in the aggregate of the theoretical models? In addition to the elements of the aggregate model, there were several additional elements relayed to the researchers by the respondents. Some of these elements were used in the implementation of the RFID project, while others were considered by the respondents to be missing from the process. The researchers also contributed some potential elements to refine the model. The additional elements are listed in Table 5.7. Each individual element is followed by its source.

The first additional element is management style. The "hands off" management style of the section chief (upper management) affected the responses given by the project manager. The project manager, feeling the absence of a team approach, carried the full burden of success or failure. This management style contributed to an observed lower score in political attitudes, external pressure, and teamwork. This management style has also left the workers uninformed.

Another additional element concerns failure assessment. Probability of success was part of the aggregate model. However, the consequence of failure or failure assessment was absent. Three of the organizations; contractor, project manager, and line workers, appear to have greater consequences of failure than the MITLA organization and upper management. If the project is not successful, the contractor will be less likely to get new government contracts for similar projects, the project manager will

TABLE 5.7. SUGGESTED ADDITIONS TO THE AGGREGATE MODEL.

Additional Implementation Element	Source of the Element
Management Style	Researchers
Failure Assessment	Researchers
Line/Staff Organization Involvement	Researchers
Funding Source	Researchers
Proven/Unproven Technology	Researchers, Contractors
Existence of Internal Champion	Contractors
Involve End User From the Beginning	Contractors, Line Workers
Senior Management Support and Involvement	Line Workers

have the stigma of a failed project to contend with, and the workers will not have the benefits possible with the technology. The scores were usually higher for the organizations with the lowest failure consequence. Risk and consequences of failure tend to have a lowering effect on the importance of the aggregate model elements.

Classification of an organization as "line" or "staff" is related to failure assessment. Line organizations, such as the contractor, project manager, and line worker seem to place less importance on the aggregate elements than do staff organizations. This may be due to their relative distance from the implementation. Line organizations are typically close to the implementation action; whereas, staff

organizations usually monitor the implementation from a distance.

The fourth additional element involves the source of funding for the project. Although availability of funding is included in the aggregate model, the source of funding can play an important role in the success or failure of the project. Internal or competitive funding may tend to be more conservatively spent than free or non-competitive monies. This project was funded with non-competitive funding and, therefore, avoided some local resource monitoring. The original estimates for this project were understated; consequently, additional funding was required. The original requirements were broader than if the funding were competed.

Next, the question of whether or not the technology is proven may be considered as an element of the model. RFID is a new, state-of-the-art AUTO ID technology that has not been used to dynamically inventory and track moving parts on this large of a scale. One contractor suggested success is more difficult to define in unproven technologies because each implementation is unique and provides further insight into the capabilities of the advanced technologies. Proven technologies have enough of an application base to gauge success.

The RFID contractor cited the existence of an internal champion as a success factor. The more powerful this individual is, the better the chances of a successful

project. Complex, unproven technology projects can get delayed or stalled in the bureaucracy of large organizations. A strong, powerful advocate is essential to break the gridlock.

Both contractors agreed that involving the end user from the beginning of the project is key to the successful implementation of advanced technology. The users knowledge base should be tapped during all phases of the implementation. Besides increasing the probability of providing a technology familiar to the user, the user is encouraged to learn and explore the new practices as a team player.

Finally, the level of senior management support and involvement may play a key role in developing an effective technological implementation model. Too often projects are envisioned, well designed, well implemented, but not supported by senior management. Line workers must experience senior management's commitment and support for the technology implementation. This commitment assists senior management in getting the users to buy in to the new system. Users who see this commitment will be more easily convinced that the new system will benefit them.

<u>Other Implementation Considerations</u>. During the course of this research other implementation suggestions were noted in this section.

Visibility of the technology may also be a factor in developing a model. As seen in marketing campaigns, the

more visibility that a product can obtain, the more likely that product is to sell. This idea holds true for new technologies as well. If a project manager can get some high-level visibility, the support received from those high-level individuals may help ensure the success of the project.

Motivation may also be added as an element to the model. Individuals and organizations that tend to be early adopters and/or highly motivated tend to be on the cutting edge of technology. They exhibit more risk-taking abilities and are more likely to implement advanced technologies.

This RFID project started with very broad requirements. The application contractor suggested that a requirements analysis be accomplished before the development of a Statement of Work (SOW). However, tight requirements in unproven technologies may limit the flexibility of applying unknown advanced capabilities to requirements.

Responsiveness to user needs after the system is installed may also be an element of the model. Very few advanced technologies are implemented without some technical or procedural difficulties. The period after the system has been turned over to the users is called the shakedown period. It is critical to have fast, responsive support to the user's needs during the shakedown period. User attitudes are formed in a very short period. If failures are not addressed immediately, confidence in the system may never recover.

Whether or not a method of evaluating the system after it is up and running was incorporated into the project is another potential element to be considered. Advanced technology is usually implemented in stages. The first implementation is considered a trial implementation with other implementations to follow once the trial is successful. The contractors recommend building in an EA data collection system and error-tracking system to help in future applications of the technology. The EA data collection system provides critical data with which to measure success and provide documented benefits. The error-tracking system will help with debugging during the critical burn-in and shakedown period, where user attitudes are formed.

One line worker suggested a trouble shooter to work with the users of a newly implemented system. This extends the champion idea to the working level. Again, this trouble shooter is protecting the system during the shakedown period.

Additional Considerations

Based on the models analyzed and the RFID case study the following considerations are recommended to improve the probability of success for an advanced technology implementation. These guidelines are intended as a supplement to other guidance published for decision making and project management.

(1) Thoroughly investigate and document the total requirements for the project as they are known in the early stages of development. This includes requirements from all involved and affected organizations such as the ultimate user.

(2) Leave flexibility in the contractual documents and relationships with organizations involved. Some requirements can not be foreseen in an advance technology implementation.

(3) Secure early buy-in by the users of the final implementation as soon as possible. Involve them in any of the changes or additions to requirements. The user represents a valuable source of application knowledge.

(4) Design the system to minimize change for the user.

(5) Start with a manageable prototype implementation which will not disrupt the existing system.

(6) Once the system is operational ensure adequate trouble shooting resources and or project personnel are available to correct problems quickly.

(7) Do not overestimate the positive affects of the new technology. New technology implemented within a poorly structured organization will be limited in its abilities.

(8) Do not underestimate the value of training. Training intended to show the correct use of the system is also an avenue to inform the user of the benefits of the system.

Future Research

This study can be used as a basis for developing a more refined implementation model for new Air Force technologies. Hopefully, an Air Force Institute of Technology research team will use this study to further this investigative effort. To that end, the following are offered for future research efforts.

First, the survey used for this study was developed to assess the applicability of the aggregate model elements to a particular implementation of RFID at a single location. As such, the questionnaire did not lend itself to gathering sufficient quantities of data in a format that could be statistically analyzed. With this in mind, subsequent researchers should update the questionnaire/survey to include information that can be easily analyzed through statistical methods. The confidence level at which the relationships between variables could be evaluated would then be improved.

Second, this study involved a snap shot of the Kelly engine facility, during which RFID was not installed and working. Another research team could make a longitudinal study. The same people interviewed during this research could be interviewed after the RFID system is fully operational. This longitudinal study would show if opinions changed as the system matured.

Next, this study focused on a single application; therefore, different types of technology implementations

could not be compared and contrasted. This application involved the use of RFID, which may be suited to only certain types of applications. These applications may have significantly different characteristics than alternate technologies used for other applications. A well-developed study, based on the foundation set in this thesis, would identify and analyze these differences.

Finally, eight elements were identified in Table 5.2 that were not parts of the aggregate model. Some of these elements were suggested by the researchers, while others were suggested by respondents. Subsequent investigators should explore the possibilities of integrating these elements into the aggregate model and including survey questions that will assess the applicability of these elements to various technological applications.

Appendix: Questionnaire-RFID Implementation at Kelly AFB

You have been selected to respond to the following questionnaire pertaining to the implementation of Radio Frequency Identification at the F-100 engine overhaul facility at Kelly AFB. Various authors have developed models/guidelines to assist in the implementation of new technologies. We (Mr. Mark Reboulet and Capt. Phil Robinson) have researched these models and have developed a separate model that incorporates the significant elements found in the literature. The purpose of this questionnaire is to highlight areas that must be considered when installing new technologies in organizations. Your expertise is necessary to help us identify areas that we may have missed and to help validate our model.

Instructions.

Please familiarize yourself with the questions contained in this questionnaire and think about how you would answer them. We will meet with you on Wednesday, 19 May or Thursday, 20 May and personally administer the questionnaire. We will solicit your responses to the open-ended questions and will ask you to rate your feelings on the scaled questions. The following scale will be used to scale your feelings. We look forward to visiting with you and are confident that your help will greatly benefit our study.

Scale.

Very Unimportant	Unimportant	Slightly Unimportant	Neither	Slightly Important	Important	Very Important
1	2	3	4	5	6	7

Demographics.

1. What is your name and phone number?

2. What is your gender?

3. What is your age?

4. What is your rank/grade?

5. How long have you been in the organization?

Information Availability.

1. Were you directly involved or did you have direct input in the selection of RFID as the technology solution?

    * How important was this for you?
    1 2 3 4 5 6 7

2. How often were you involved in the selection of RFID?

    * How important was this for you?
    1 2 3 4 5 6 7

3. Did you require additional or clarifying information from what was initially presented (written or oral)? If so, what kind?

* How important was this for you?
1 2 3 4 5 6 7

4. Were you provided status updates or additional information as to the progress of the project once it was started? If so, what kind?

* How important was this for you?
1 2 3 4 5 6 7

5. Was enough information available to ensure all technical requirements were met (eg. hardware interfacing, functional requirements, etc.)? If not, what was missing?

* How important was this for you?
1 2 3 4 5 6 7

Anticipated Profitability.

1. Was an economic analysis accomplished in conjunction with this project?

* How important was this for the success of the project?
1 2 3 4 5 6 7

2. Do you feel that the implementation was cost justified? Why or why not?

* How important was this for the success of the project?
1 2 3 4 5 6 7

Probability of Success.

1. Were other alternatives pursued as candidates for this project? If so, which ones?

* How important was this for the success of the project?
1 2 3 4 5 6 7

2. Were goals and expectations developed to measure the project's success?

* How important was this for the success of the project?
1 2 3 4 5 6 7

Users Attitudes.

1. What was your initial attitude toward this project?

2. How has your attitude changed since the project was first conceived?

Political Attitudes.

1. Was this a voluntary project or mandated by higher authority?

2. What are the goals of your organization?

3. Do you feel RFID will help bring you closer to your organizational goals? Why or why not?

* How important was this for the success of the project?
1 2 3 4 5 6 7

External Pressure.

1. Did you see opportunities where your organization could benefit from the use of RFID?

2. Was there some sort of competition/threat that caused you to search for alternative technologies?

3. Was this project born from within the organization or suggested by an outside source?

* How important were external pressures for success of the project?
1 2 3 4 5 6 7

Teamwork.

1. Was an implementation team created to manage the implementation of this project?

* How important was this for the success of the project?
1 2 3 4 5 6 7

2. Were you a member of the implementation team?

* How important was this for you?
1 2 3 4 5 6 7

3. Did your involvement effect your attitudes toward the project?

* How important was this for you?
1 2 3 4 5 6 7

Strategic Planning.

1. Were you aware of the existence or did you participate in the development of corporate goals which this project satisfied?

2. Do you feel this technology will help you meet the goals of the organization?

* How important was this for the success of the project?
1 2 3 4 5 6 7

Resource Availability.

1. Who provided funding for this project?

2. Were adequate financial resources made available?

* How important was this for the success of the project?
1 2 3 4 5 6 7

3. Were adequate manpower resources made available?

* How important was this for the success of the project?
  1 2 3 4 5 6 7

4. Was adequate time made available?

* How important was this for the success of the project?
  1 2 3 4 5 6 7

Training.

1. Has training been incorporated into this project? How?

* How important was this for you?
  1 2 3 4 5 6 7

2. Is/will continuation training being provided? How?

* How important is this for you?
  1 2 3 4 5 6 7

3. Do you feel competent to operate the RFID system and its peripherals?

* How important is this for you?
  1 2 3 4 5 6 7

* How important is this for the success of the project?
  1 2 3 4 5 6 7

4. Do you feel competent to maintain the system?

* How important is this for you?
  1 2 3 4 5 6 7

5. Do you feel competent to make improvements to the system? How?

* How important is this for you?
  1 2 3 4 5 6 7

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13. ABSTRACT *(Maximum 200 words)* This research developed an aggregate model for technological implementation in organizations. The aggregate model drew information from various theoretical models and aggregated those elements that were common to several of the models. Those elements included: information availability, anticipated profitability, probability of success, user attitudes, political attitudes, external pressure, teamwork, strategic planning, resource availability, and training. Individuals involved at various organizational levels of a Radio Frequency Identification implementation were interviewed to see if the aggregate model could be useful to managers. The researchers found evidence that each of the elements of the aggregate model could be beneficial to managers considering implementing new technologies. Also, the researchers found that individuals at different organizational levels tended to view these elements differently. Additionally, the researchers recommended several elements that could be added to the model. Future research should be conducted to determine if these additional elements should be added to the aggregate model and to determine if the model is useful for various types of technologies.

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